DARPA Advanced Logistics Transceiver Study

Maurice C. Perdomo, Charles H. Sinex, and Raymond L. Yuan

Logisticians today must be able to locate combat-trackable items (major end items) on the battlefield “in theater,” but a Joint systems-level capability to do so is not available within DoD. The Information Systems Office of the Defense Advanced Research Projects Agency commissioned the study described in this article to determine the concept of operations and perform a communications analysis for a system of small, expendable tags to operate in several logistical settings using a variety of communications relay payloads. This article defines the logistics problem (number of units, message length, frequency, bandwidth, power, communications relay, etc.) from which a development effort could be initiated to field a system within roughly the next 25 years.

(Keywords: Concept of operations, Logistics, Tags, Transceivers.)

INTRODUCTION

A variety of logistics transceivers (commonly called “tags”) exist in the commercial and defense sectors to track the movement of everything from a small microchip to a 5-ton truck. The ability to know an item’s location and status has profit implications for those in business and readiness implications for warfighters. Two of the most common types of such transceivers are radio frequency (RF) tags and bar codes. They carry information such as an item’s name, identification number, transportation carrier, location, etc. The most common RF tag can carry up to 128,000 bytes of data.

Today, tagging technology is geared toward commercial applications and is usually unique to a product or particular industry. DoD has leveraged this technology from the commercial sector and applied it for its own uses. There have been many challenges in integrating these tags into the operation of the Services. In most cases, each Service has selected different tags, protocols, and information systems, making a global defense picture of asset visibility difficult.

The Defense Advanced Research Projects Agency (DARPA) has chosen to make a system-of-systems examination of the problem to determine if advanced technology can remedy the situation. APL was tasked to determine a viable concept of operations and perform a communications analysis for a potential system of small, expendable tags. These tags would operate in various logistics settings from now through the 2025 time frame using communications relay payloads to monitor and transmit the necessary information to warfighters and logisticians. The APL study focused on the in-theater logistics problem to assess the significant parameters involved, and just as importantly, to emphasize the impact of those parameters on warfighting operations. In addition, combat-trackable items (major end items such as weapon systems, trucks, command
and control [C²] equipment, etc.) required for combat readiness were selected for in-depth study to determine minimum tracking capability.

THE PROBLEM

All of the Services have their own unique Automated Information Systems (AIS) that collect logistics data (e.g., receipt, location, owner, destination) about their assets. Procedures and formats differ in every case. The individual systems feed the DoD databases for a more global picture. The aim of the Joint Total Asset Visibility (JTAV) Program is to facilitate and encourage the development of a common logistics picture on asset visibility, both within and outside the theater, based on information from all Service AIS and DoD databases.

Automated Information Technology Systems (AIT), also called Tagging Systems, are specific to the Services and feed each Service's AIS. Again, these systems are all different; there are no common standards among them. The JTAV Program can only recommend policy. Currently, no integrated asset visibility system, either AIS or AIT, exists. The goal, therefore, is to achieve an integrated system of systems in which the logistics picture can be drawn from the AIS. Reliability of and access to AIS are vital. An AIT is just one mechanism for passing information to an AIS from which the user can access intelligence.

Further complicating the issue is the way in which this problem is being addressed by the different warfare communities (C², logistics, and combat identification [ID]). Each is attempting a similar end (theater-wide surveillance of friendly forces and assets), but with different systems and with no coordination of effort. The vision should be one integrated visibility system. Just as the Services are using different systems, the various warfighting communities are seeking different solutions. Cooperation and pooling of scarce funding could go far in fielding a capable Joint system.

TAGGING SYSTEM CONCEPT OF OPERATIONS

The concept of operations developed for this future generation of tagging systems (Fig. 1) gives DoD the capability of tracking all transportation assets, containers, and combat-critical items wherever they are in the theater or logistics pipeline. The basic approach is to adopt a tiered tracking system for containers, prime movers, and combat-trackable items via satellite and/or unmanned aerial vehicles (UAVs). “Tags” will report with a short “license plate” message of ≈25 bytes, giving an item’s ID number, unit ID code, and location, or with a slightly longer status message of ≈100 bytes, giving information such as vehicle faults or breakdowns. The message will be downlinked to an AIS.

![Figure 1. Concept of operations (diamonds represent input to the Automated Information System [AIS] computers, network, and databases via readers; UAV = unmanned aerial vehicle).](image-url)
This AIS will contain much more information, such as the entire contents of the containers (≈100 KB), and will be updated via readers at various points in the logistics system. The entire system relies on access to the AIS infrastructure, and this is consistent with current DoD policy and efforts.

REQUIREMENTS

The development of any future advanced tagging system must be based on operational requirements. Therefore, the first phase of the APL study concentrated on collecting requirements for asset visibility from the Services and agencies. No authoritative requirements documents were found, other than those for the JTA V Program. However, all the Services are participating in the program and are pursuing their own asset visibility objectives.

Requirements were also derived from operational scenarios. Two operational extremes—the Southwest Asia Major Regional Contingency (MRC) and Operational Maneuver from the Sea (OMFTS)—were selected to determine coverage and data flow needed within a theater. The MRC, which is patterned after Desert Storm, examined the introduction and support of large numbers of Joint forces operating within an extended geographic area. The second scenario, based on the Marine Corps’ OMFTS concept, helped to highlight the need for a responsive and secure system capable of supporting small, highly mobile units.

The MRC scenario amplifies the need for any asset visibility system to be able to cover a vast area containing tens of thousands of combat-trackable items. In this MRC, large numbers of U.S. forces are deployed to Saudi Arabia. Both the size of the area of operations (≈160,000 km², Fig. 2) and the significant number of U.S. troops make this operation logistically strenuous. In such a scenario, rapid movement of materiel through the relatively few Saudi ports is critical to achieving U.S. objectives.

The OMFTS scenario (Fig. 3) places small groups of Marine forces ashore over a widely dispersed area. All logistics requirements will initially be provided from amphibious ships at sea (sea-based logistics), as far as 100 nmi from the shore. In time, a small Combat Service Support Operating Center (CSSOC) will be deployed ashore to provide logistical support to the forces. However, the CSSOC will still rely on the sea base for sustainability. Given the limited logistics footprint available ashore, this scenario highlights the need for rapid and robust communications and resupply. Also, because these Marine forces will be (relatively) lightly armed and reliant on rapid maneuver and surprise, the need for protection against RF exploitation is critical. Although the OMFTS scenario covers a smaller area than the MRC scenario, it still indicates the need for a tracking system to monitor many items over a wide area. In addition, since there is no infrastructure on shore, a satellite or UAV would be required to relay status to the sea base or CSSOC.

Every Service wants to know what it has, where its assets are, and what the status of its materiel is. In the theater (i.e., a secure environment), this knowledge is essential; however, as activities shift back to the continental United States, the need for secure transmissions is less critical. Finally, this knowledge must be acquired at a low cost to enable the Services to put their systems into operation, replace functions currently performed by personnel, and allow more of the force structure to be placed in the combat units as the overall size of the force is reduced. Thus, the operational requirements for a tagging system must consist of situational awareness, security, and cost.

Because of the diversity of DoD’s operating environments, one requirement documented by the DoD AIT Working Group was the need for a suite of AIT devices. This suite will consist of linear bar codes, two-dimensional bar codes, optical memory cards, RF ID tags, and satellite tracking systems. In addition, AIS must capture and provide departure and arrival information to logistics decision makers and customers throughout DoD within

- 1 h for all shipments of unit and nonunit equipment from original source of supply
- 1 h for all air shipments
- 4 h for all ocean surface shipments
- 2 h for all intratheater shipments
- 0.5 h for in-theater container and power unit tracking
DoD will ensure the full operability of all AIT and AIS devices.

Based on operational requirements, APL studied and selected system options. Although this task focused on advanced transceiver technologies, commercial off-the-shelf (COTS) products were examined. The philosophy of the effort was to use commercial technology and services as much as possible and focus development on any technology deficiencies; the vision was to integrate any logistics data flow with C2 and combat ID systems. (The Selected Bibliography at the end of this article lists various resource materials on the topics covered here.)

**FINDINGS**

**Tag Types and Architecture**

Given the operational requirements defined by the scenarios and those gathered from the Services, we identified four tag types to meet the stated goals: (1) item, (2) strategic lift asset, (3) container/power unit, and (4) combat-trackable. Each type corresponds directly to an item or specific type of vehicle. The item tag, which could be attached to an item or to the box in which it is placed, would track the item in the factory or warehouse and could be used to generate a vehicle manifest automatically (when the item is loaded onto a vehicle for transport). The tag used on a strategic lift asset must be a communications system that specifically addresses transoceanic communications requirements. The container/power unit tag would permit tracking of a container or power unit over a wide area. In addition, it would have a high data rate download capability to support manifest download (containers) or real-time engine monitoring (power units). Similarly, the combat-trackable item tag would permit tracking over a wide area as well as high data rate download.

To define the specific capabilities of the tag, one must consider the overall architecture of the tagging system. For this study, we examined three such architecture options.

1. **ID-only.** Tag provides ID data only (name, serial number, unit ID code, and perhaps limited status information about the item). All detailed information about the item (manufacturer, manifest list, condition code, billing information, etc.) is maintained in the infrastructure. This approach is likely to minimize tag capability (and thus cost), but places demands on the logistics information infrastructure to provide reliable and timely information on the items.
Combat-trackable items per brigade, including tanks, to those of power units. There are expected to be 350
and Vehicle Master Processing Unit). Amphibious Assault Vehicle Engine Control System
is based on the data flow between the Advanced
by the vehicle. However, if real-time diagnostic data on
consumption) as well as any fault conditions identified
message could be limited to less than 100 bytes. It could
would decrease dramatically.
technology were used, but the communications range
(to rates on the order of 500 KB/s) if COTS tagging
5.5 min. This data rate could be increased substantially
transmission to a short 25- to 100-byte message.
ID and limited status only, it will be possible to limit
update rate. If the container tag is required to send an
required to send an
ID-only option.
Tags for container/power units will require signifi-
cantly more capability than the item tag since such
units must be tracked over a wide area and will poten-
tially transfer more data. The requirements for these
tags fall into three categories: (1) data transferred per
unit, (2) number of units tracked, and (3) tracking
update rate. If the container tag is required to send an
ID and limited status only, it will be possible to limit
transmissions to a short 25- to 100-byte message.
However, a full manifest would require transmitting up
to 100 KB. At 2400 bits/s, which is a typical digital
voice data link rate, a manifest download would take
5.5 min. This data rate could be increased substantially
(to rates on the order of 500 KB/s) if COTS tagging
technology were used, but the communications range
would decrease dramatically.
Like the container tag, the power unit ID and status
message could be limited to less than 100 bytes. It could
contain the status of critical parameters (e.g., fuel
consumption) as well as any fault conditions identified
by the vehicle. However, if real-time diagnostic data on
power-train operation were required, a continuous
1200-bits/s data link would be necessary (this estimate
is based on the data flow between the Advanced
Amphibious Assault Vehicle Engine Control System
and Vehicle Master Processing Unit).
Combat-trackable items have requirements similar
to those of power units. There are expected to be 350
combat-trackable items per brigade, including tanks,
artillery, C^2 systems, etc. Therefore, in the MRC sce-
nario, 8400 units would need to be tracked across the
theater. Near–real-time updates would be required on all
these units during combat.
From an architectural perspective, the ID-only op-
tion is appealing because it is likely to have the lowest
cost. It also makes many wide-area tracking options
viable. However, this option relies on the logistics in-
formation infrastructure to continuously provide accu-
rate and timely data. Since the design of this system
must anticipate crisis situations, selection of an archi-
tecture that can operate with a degraded infrastructure
is desirable. Therefore, the architecture assessment
leads to the option where both the ID and the full
details are provided by the tag. In this case, however,
the full details are not transmitted over wide-area RF
communications, but rather are used only when local
interrogation is necessary and can be accomplished
using a high data rate mode. The wide-area tracking
requirements are met using a low data rate ID-only
mode. Table 1 summarizes the system architecture
assessment for combat-trackable items.

### Tracking Technology

The technology options to meet the selected tag
architectures can be divided into two groups, the first
addressing the local interrogation options (e.g., while
a vehicle is in a maintenance bay), and the second
addressing the wide-area tracking options. The local
interrogation capability can be focused on a high data
rate download to obtain manifests and support the
transfer of real-time engine diagnostics. This capability
is currently available through COTS products and stan-
dards. Wide-area tracking options have been limited to
military systems and commercial satellite systems, even
though there are security concerns associated with the
latter.

Given the need for theater-level coverage, terrestrial
military or commercial wireless operations are severely
hampered by the line-of-sight requirement for radio
communications. Terrestrial wireless systems typically
cover less than 20 km (radius) per base station. In
addition, the base stations cannot be redeployed rapidly
enough to cover highly dynamic situations. Conversely,
UAV- and satellite-based options (Table 2) can cover
significantly more area with less infrastructure. The
satellite altitude alone suggests that a single low-Earth
orbit (LEO) satellite could cover thousands of kilome-
ters, although a constellation of satellites would be
needed to provide continuous area coverage.

Given the lack of existing military satellite systems
to support mobile users and the potentially significant
expense in deploying such a system, the military satel-
life option was not considered viable. However, com-
mercial satellite systems are viable, assuming certain
security issues can be addressed, because of lower costs. Although the UAV option would require funding for development, it would permit the government to own the complete signal path, thereby mitigating several potential information security issues raised when using a commercially operated communications system.

Table 1. Combat-trackable item tag system architecture assessment.

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Option</th>
<th>ID-only</th>
<th>Full details</th>
<th>Combined</th>
</tr>
</thead>
<tbody>
<tr>
<td>Situational</td>
<td>Depends on reliable</td>
<td>Requires high data rate</td>
<td>Requires ID and limited status information only or wide-area tracking plus a high data rate download for local interrogation</td>
<td></td>
</tr>
<tr>
<td>awareness</td>
<td>infrastructure</td>
<td>communications link</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Security</td>
<td>Provides security owing to</td>
<td>Requires access and privacy protection; in-theater use may also have to address RF exploitation</td>
<td>Requires access protection or local interrogation only</td>
<td></td>
</tr>
<tr>
<td></td>
<td>limited amount of information transmitted</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>Offers low (&lt;$100) tag cost</td>
<td>Requires development of a wide-band over-the-horizon communications system</td>
<td>Combines low-cost over-the-horizon communications system and high data rate (short-range) download</td>
<td></td>
</tr>
</tbody>
</table>

Note: The “combined” architectural option is recommended.

Table 2. Combat-trackable item tags for wide-area tracking.

<table>
<thead>
<tr>
<th>Option</th>
<th>Situational awareness</th>
<th>Security</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>Terrestrial military</td>
<td>Geographic coverage is limited by base station deployment</td>
<td>Physical control of base station, encryption, and specialized waveforms would enhance security</td>
<td>Assuming base stations are supporting C², data terminal cost is a driver</td>
</tr>
<tr>
<td>wireless system</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>UAV</td>
<td>Coverage is a function of altitude</td>
<td>Transmit power is low (compared with satellite solutions); UAV and ground segment are physically secured</td>
<td>Includes development of UAV systems to support logistics</td>
</tr>
<tr>
<td>Military satellite</td>
<td>Continuous coverage is provided by GEOS; otherwise a large LEO constellation is required</td>
<td>Physical control of satellite and ground segment, encryption, and specialized waveforms would enhance security</td>
<td>Includes development of a satellite system</td>
</tr>
<tr>
<td>Commercial satellite</td>
<td>GEO or LEO MSS can provide continuous coverage; capacity limitations exist</td>
<td>Use of commercial (foreign) gateways; RF exploitation is an issue</td>
<td>Data terminals must be modified to address security</td>
</tr>
</tbody>
</table>

Note: LEO = low-Earth orbit; GEO = geosynchronous Earth orbit; MSS = mobile satellite system. UAVs and commercial satellites are the recommended options.

Based on the detailed requirements and a comparison of UAV versus commercial satellites, a functional description of the container/power unit tag for in-theater tracking is possible. There are at least two operating mode options: high data rate, short-range; and low data rate, low-power/commercial LEO. The former will
permit the rapid download of full manifests or engine
diagnostic information to be transmitted in real time.
The latter would be used with a UAV, if one is available
and security risks require the user to resort to it. How-
ever, if costs and security issues are addressed, this mode
could be based on the commercial LEO instead.

The high data rate mode can be supported by exist-
ing tagging products. This mode should be exactly the
same as the high data rate mode in the container tag.
The low data rate, low-power mode (and the accom-
panying UAV system) would have to be developed.
Commercial LEO constellations will soon be available,
but all the modifications needed to support the required
security features may not be.

In addition to the operating modes, the tag should
be microprocessor controlled (with a standardized in-
terface to off-tag sensors or processors) so that it can
adapt more readily to different applications. For exam-
ple, the tag may simply act as a pass-through for real-
time engine diagnostics; however, it may also need to
buffer specific information in the diagnostic flow, iden-
tify fault conditions from sensors, etc.

RECOMMENDATIONS

For an item tag, we found that an RF (ID-only) tag
could be used in the manufacturing and warehousing
environments and could support automanifesting as
well. The container/power unit tags and combat-track-
able item tags will require significantly more capability
than the item tag because of the need to track units
over a wide area and transfer more data. In depot, an
RF (high data mode) tag on containers or power units
will permit high data rate download of manifest or
sensor information. For wide-area (theater-wide) track-
ing, a UAV or commercial satellite will allow continu-
ous coverage of containers/power units and combat-
trackable items. Terrestrial wireless systems are limited
by short line-of-sight communications (<20-km radius
per base station), whereas one

LEO satellite can cover an area
1000 km in diameter. Given the
need to track over 30,000 items in
theater, it is possible for a satellite
to provide this coverage. Where
satellite coverage is lost, UAVs
could fulfill the requirement of
any localized area (battalion-
to
division-sized units).

Figure 4 illustrates a typical
commercial voice-capable (“Big”)
LEO mobile satellite system sce-
nario. These satellites operate at
altitudes of several hundred to
over 1000 km, providing coverage
over a region several thousand
kilometers in diameter. Each satellite is visible for only
a few minutes, so a large constellation of satellites is
necessary to provide continuous area coverage (e.g.,
Motorola’s Iridium satellite system consists of 66 satel-
ites that provide continuous global coverage). Each
satellite’s coverage area is further subdivided into an-
tenna beams that are functionally similar to terrestrial
 cellular system cells. Beams vary in size up to 1000 km
in diameter, thus a single beam would be able to cover
an entire theater.

In addition to satellite antenna coverage, a critical
mobile satellite system component is the gateway,
which receives information from the space segment and
routes it to the public switched telephone network. If
the satellite system uses processing satellites with cross-
links, like Iridium, a gateway could provide service to
a handset located anywhere. The satellites receive hand-
set transmissions and route the calls over the cross-links
from satellite to satellite, until they reach a satellite
that can downlink the calls to the gateway. However,
if the satellite system uses transponding satellites, like
Loral/Qualcomm’s Globalstar, then a gateway and hand-
set must simultaneously view the same satellite to com-
municate. Thus, gateway location limits connectivity.

Table 3 presents data for two commercial satellite
systems, Globalstar and Iridium. In this case, 32,800
transceivers (14,400 trucks, 8,400 combat units, 10,000
containers) might be interrogated for their 25-byte
license-plate message or their 100-byte status message.
Additionally, the 10,000 containers carry a full-
manifest database that has a size on the order of
100 KB for each container.

Table 3 shows the minimum required reporting times
to send full-manifest data from each container through
the data channels. Although these times are based on
the maximum number of channels that might be avail-
able, it is extremely unlikely that anything close to such
numbers would actually be allocated. Consequently,
the total reporting time will probably be much greater
than the 1 h indicated. However, 1 h still exceeds the in-theater allowable time of 0.5 h mentioned earlier. Based on these times, the use of commercial satellites for full-manifest reporting would seem infeasible. The AIS infrastructure appears to be better for carrying the full-manifest data, with periodic updates as containers pass choke points.

There is more flexibility in reporting the 25- or 100-byte status messages. If each transceiver were individually called, the total time to cycle through all 32,800 transceivers without receiving acknowledgments is 10 to 15 min, depending on the satellite system. Although this is within the minimum required reporting time, the individual “dialing” approach saturates the access channel for significant blocks of time, preventing access by other users. The 100% duty cycle for calling may also raise power concerns.

Two alternative approaches are shown in Fig. 5, based on paging the entire field of transceivers and then letting them randomly report back on the paging channel during some time period. This paging approach frees the access channel for other users. Of course, some combination of the two approaches could also be employed.

Figure 5a shows the basic concept for tracking tags with Globalstar using code division multiple access (CDMA). The theater contains 24 brigades with 14,400 trucks, 8,400 combat vehicles, and approximately 10,000 containers. The satellite has 1 paging channel, 1 access channel to set up calls, and 128 voice channels in each beam; 1 beam will cover the theater. The concept is to use the access channel to report the 25- or 100-byte messages along with the regular voice users. This approach has two limitations: 2 messages originating within 0.1 ms of each other “collide” and are lost, and no more than 40 messages can be carried at one time over all 130 channels. DoD would also have to purchase a gateway to operate in this mode.

The simplest way to conduct an inventory is to “strobe” the field of tags via the paging channel and request that they randomly report back over some time window $T$. One then accepts some reasonable number of lost messages, with a good chance that those units would be received at the next inventory. If the messages were perfectly synchronized, minimum reporting times would be 0.5 min for 25 bytes and 2 min for 100 bytes, indicated by the colored bands in Fig. 5a. The figure also shows the loss rate and the probability that more than 10 messages will be under way at one time on the access channel. Loss rates appear low, in the few percentage range for even short inventory intervals, and

<table>
<thead>
<tr>
<th>Commercial satellite</th>
<th>No. of access channels</th>
<th>No. of data channels</th>
<th>Report manifest time ($h$)</th>
<th>Call each transceiver time (min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Globalstar</td>
<td>1</td>
<td>&lt;400 (200-ms cycle)</td>
<td>&gt;1.20*</td>
<td>10.9</td>
</tr>
<tr>
<td>Iridium</td>
<td>3</td>
<td>&lt;880 (90-ms cycle)</td>
<td>&gt;1.05*</td>
<td>16.4</td>
</tr>
</tbody>
</table>

*Number represents upper limits for available channels and lower limits for report times; actual report times are expected to be much longer.

![Figure 5](image-url)
The number of messages is usually well under 10, leaving some capacity to handle voice traffic as well. The time window numbers scale directly with numbers of objects tracked; if the number of objects doubles, so does the time to get the same loss rates. If the satellite were lost, several UAVs would be needed to provide coverage. Subsets of tags could be paged, and a limited number of tags could be called individually.

The same concept using Iridium, a system based on timed division multiple access (TDMA), is shown in Fig. 5b. With Iridium, there are three paging/ringing channels for each beam, and every 90 ms each channel carries four uplink time bins, each lasting 8.3 ms with a 30-kHz burst transmit rate. Each time bin is sufficient to carry the 25-byte short message, so four short messages can be carried by each channel every 90 ms. Four uplink time bins are required for the 100-byte status message, so only one status message can be sent in 90 ms on each channel. The same concept of strobing the field and asking for random responses during a time window $T$ is used here. For perfectly timed signals, the minimum reporting times required are much larger, 4 and 16 min for 25 and 100 bytes, respectively, because there are only three channels and they are not devoted 100% to uplink traffic. Again, one beam will cover the theater.

As with Globalstar, different signals that try to use the same uplink time window on the same channel collide and are lost, with a good chance that they will be picked up during the next inventory period. In Fig. 5b, the loss rates are shown for 25- and 100-byte messages. Again, the time window scales with number of units tracked. The proposed system concept will support the 25-byte messages, but at a slightly higher loss rate than for CDMA. However, performance significantly deteriorates for the longer status messages, with unacceptable data loss rates. The rapid deterioration for the 100-byte case comes about because the average number of messages in every 90-ms window is around two to three, making for a high probability that messages will collide. Additional constraints may also come from satellite power limitations and other design limitations in the communications system. Therefore, the Iridium TDMA is most likely unacceptable for meeting the full range of inventory update requirements.

**ROADMAP**

Since this study was intended to cover the present through 2025, a roadmap is helpful to show how today's systems will transition into future systems. As indicated in Fig. 6, a two-tiered system is proposed with the detailed data carried in an AIS infrastructure and tags communicating with this infrastructure either directly through readers at various sites or indirectly through UAV or satellite communications.

This study was not intended to address the AIS...
infrastructure directly. Programs are currently under way to build the future AIS, transforming the infrastructure from localized, stand-alone databases into a globally connected set of databases and services. This transition is shown on the bottom right in Fig. 6, moving from local databases to a global DISN (Defense Information Systems Network) backbone.

The transition expected for the tags is presented in the middle of Fig. 6. A family of tags serving various functions is envisioned, as shown by the continual growth in added capability. Today’s bar codes and RF tags will continue to have a role, but will be supplemented by tags with added capabilities. For example, tags and readers that read items loaded into or removed from containers are anticipated soon, providing an automanifesting capability. These automanifesting tags can be integrated with RF interrogation capability to provide location as well. Ultimately, advanced intelligent transceivers are expected that can monitor the status of trucks and self-propelled combat equipment, reporting not only location, but anticipated needs such as refueling requirements, or potential equipment failures. Finally, the communications will move from the current military satellites to commercial satellite systems, with UAVs providing fallback capability or increased security when needed.

CONCLUSIONS

Most logistics tagging requirements can be met with commercial technology, and development can be divided into UAV and commercial satellite thrusts. Since a number of UAV programs are under way, it would be desirable if a single UAV system could be identified for this application. The commercial satellite thrust would focus on development of waveforms and protocols that could operate over a transponding satellite system, but hide under the commercial users’ transmissions. This would decrease the likelihood of detection through RF exploitation. Resolution of other security issues would have to rely on government procurement of a satellite gateway.

There are many ongoing efforts (including DARPA’s Advanced Logistics Program) devoted to the issues of integrating the appropriate databases and information systems. Continuing efforts must be made to implement the necessary technology for a theater-wide tracking system that can eventually fill the needs of logisticians and operators.

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