SINTEF

” RFID and Wireless Technologies for Transportation Industry ”

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Research Activities RFID and Wireless Technologies for Transportation Industry

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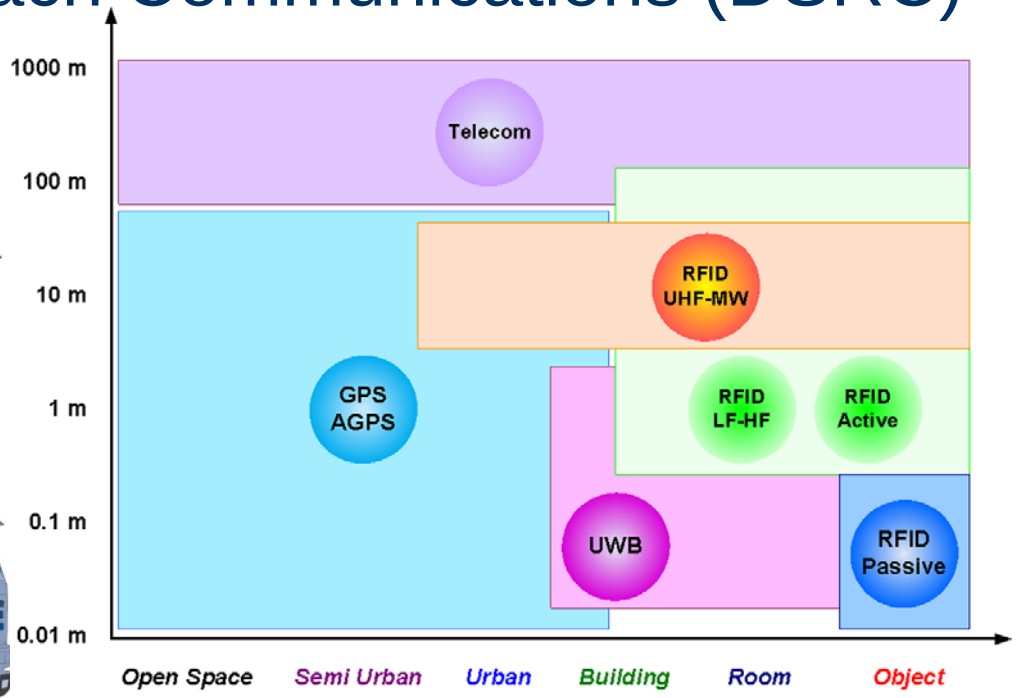
Technology Trends

- Costs of storage, processing and communications are dropping.
- RFID devices are:
  - Smaller and cheaper;
  - More functionalities;
  - Communicative and interconnected;
  - Uniquely identified.

- Move from centralized to distributed-pervasive computing.
- New tools emerging for aggregating, sharing, searching and distributing data.

Wireless Communications in ITS

- WiMAX
- Wi-Fi
- Dedicated Short Reach Communications (DSRC)
- RFID/NFC
- ZigBee
- UWB
- GPS



Identification and localisation

Wireless Communications - RFID

Type	Standards	Applications	Frequency Band				
			LF (kHz)	HF (MHz)	UHF (MHz)	MW (GHz)	
			125/134	13.56	840-956	2.45	5.8
RFID Tags	ISO 18000	Any application	18000-2	18000-3 Mode 1 Mode 2	18000-6 Type A Type B Type C (EPC G2)	18000-4 Mode 1 Mode 2	18000-5
	EPC G2	Retail, logistics, healthcare and life sciences (HLS) industry			EPC C1G2		
	ISO/IEC 11784/5	Animal tagging					
RFID Contactless Cards	ISO/IEC 14443	Proximity cards, ticketing		ISO 14443 Type A Type B			
	ISO/IEC 15693	Vicinity cards, access control					
	ISO/IEC 10536	Contact less identification cards					

Wireless Communications - DSRC

- 5.9 GHz DSRC is the emerging communication technology that offers standardized ITS products
- U.S. DOT and the automotive OEMs will be the strategic players making deployment decisions in the 2008-2009 timeframe.
- 5.9 GHz DSRC systems provide a significant enhancement in communication capabilities over all previous ITS communications systems. DSRC will support multiple uses in vehicle/public safety and commercial applications that cannot be achieved today. DSRC is a cost-effective communications service, especially when compared with current cellular and satellite systems.

Wireless Communications in ITS

- DSRC systems are not compatible with each other
  - U.S. 915 MHz DSRC
  - Europe 5.8 GHz DSRC
- 5.9 GHz DSRC has many advantages, and it is under development by various research and standards organizations.
  - The technology is envisioned as a gradual replacement of all existing DSRC systems. For several years new and old systems will co-exist.

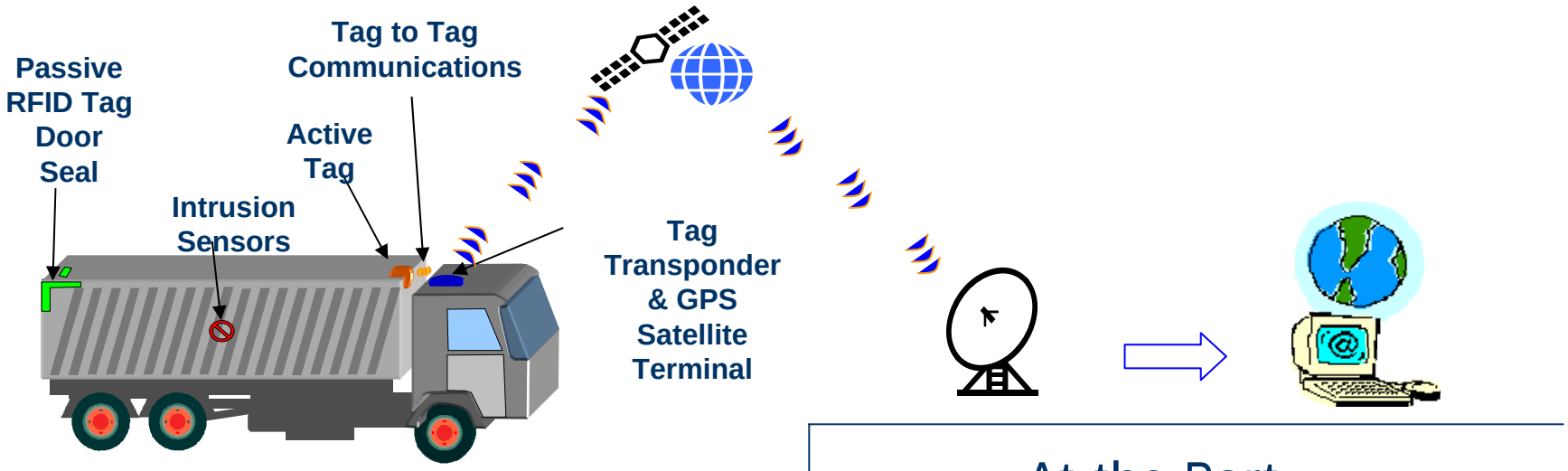
Wireless Communications in ITS

- The commercial introduction of 5.9 GHz systems is expected in 2008-2009 when IEEE ratifies the 802.11p standard
  - Today the 5.9 GHz systems market is mostly limited to research and testing
  - The 5.9 GHz technology and market maturing is expected in the 2012-2014 timeframe.
- Another communications technology that is enhancing ITS characteristics is a standard trunked radio, known in the U.S. as Project 25 radio.
  - Project 25 radio is using digital technology, is frequency efficient and originally was developed for public safety organizations.

RFID – Is this possible?

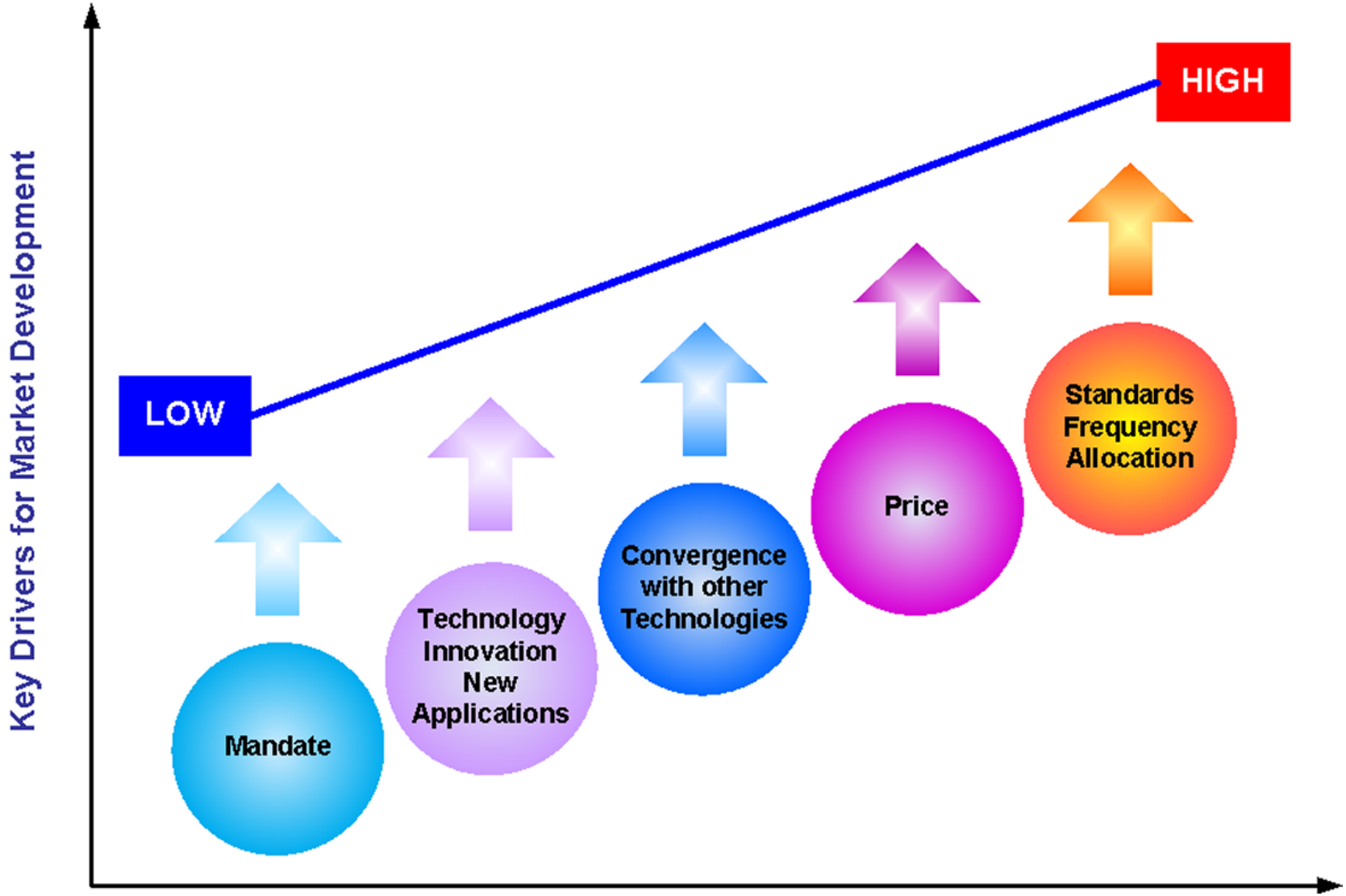
- Enabler for economic growth, increased innovation and competitiveness.
- More efficient markets.
- Productivity gains.
- Customer convenience and products recalls.
- Better service.
- Expedite processing; no bar code line of sight required.
- Improve product visibility.
- Respecting privacy, and providing security.

RFID – Is this possible?

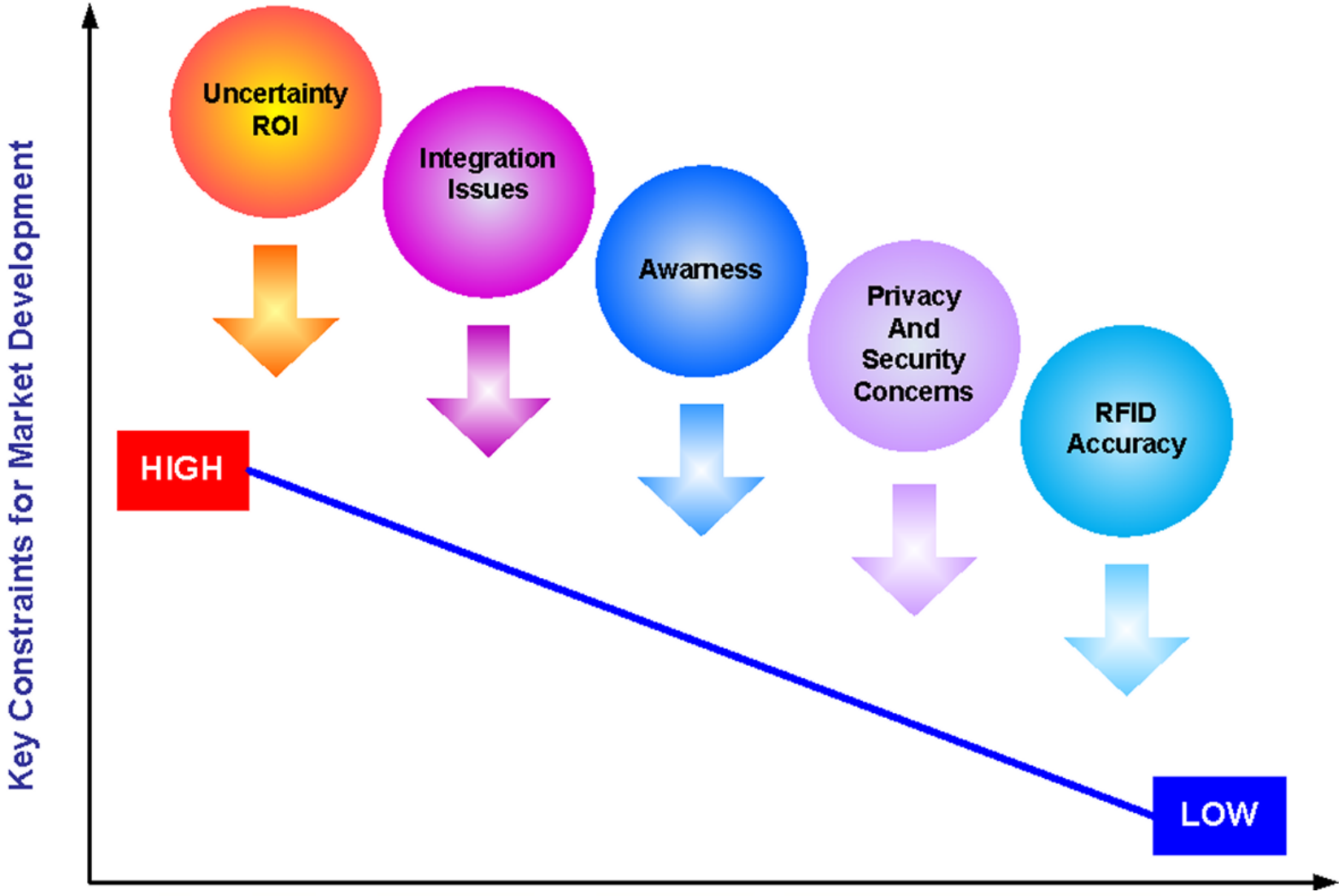


Source: Alion/DSI

RFID – Market Drivers



RFID – Market Constrains



Aeronautics Vision

- The green aircraft
- The electrical aircraft
- The intelligent aircraft
- The efficient aircraft
- The connected aircraft (wire and wireless)
- Enabling ICTs
  - Data Fusion / Management
  - Wireless Communication (RF/RFID)
  - Sensors / Actuator Systems
  - Wireless Sensor Networks
  - Integration and miniaturization

Wireless Interconnectivity

- Wireless technologies - reduce internally hard-wired communications - Research and development
  - Passive and/or active RF/RFID sensor networks
  - Tracking/RFID
  - Wireless instruments
  - Wireless PDAs, laptops
  - Wireless voice communication
  - Sensor web/mesh technology
  - Wireless sensor and RFID placement allowing better decision making

Logistics Aeronautics

	Consumer	Aeronautics
Product Lifetime	*Lifetime measured in months.*	*Typical aircraft component may have a life of 25-50 years*
Product Characteristics	*Low value and low complexity*	*High value and high complexity*
Application Areas	*Supply chain logistics applications are critical*	*After sales, product service, repair and spares management (in addition to logistics)*
Environmental Conditions	*The supply chains are relatively well controlled.*	*Aerospace components are often subject to extremely varying environmental conditions*

RFID and ID systems in Aeronautics

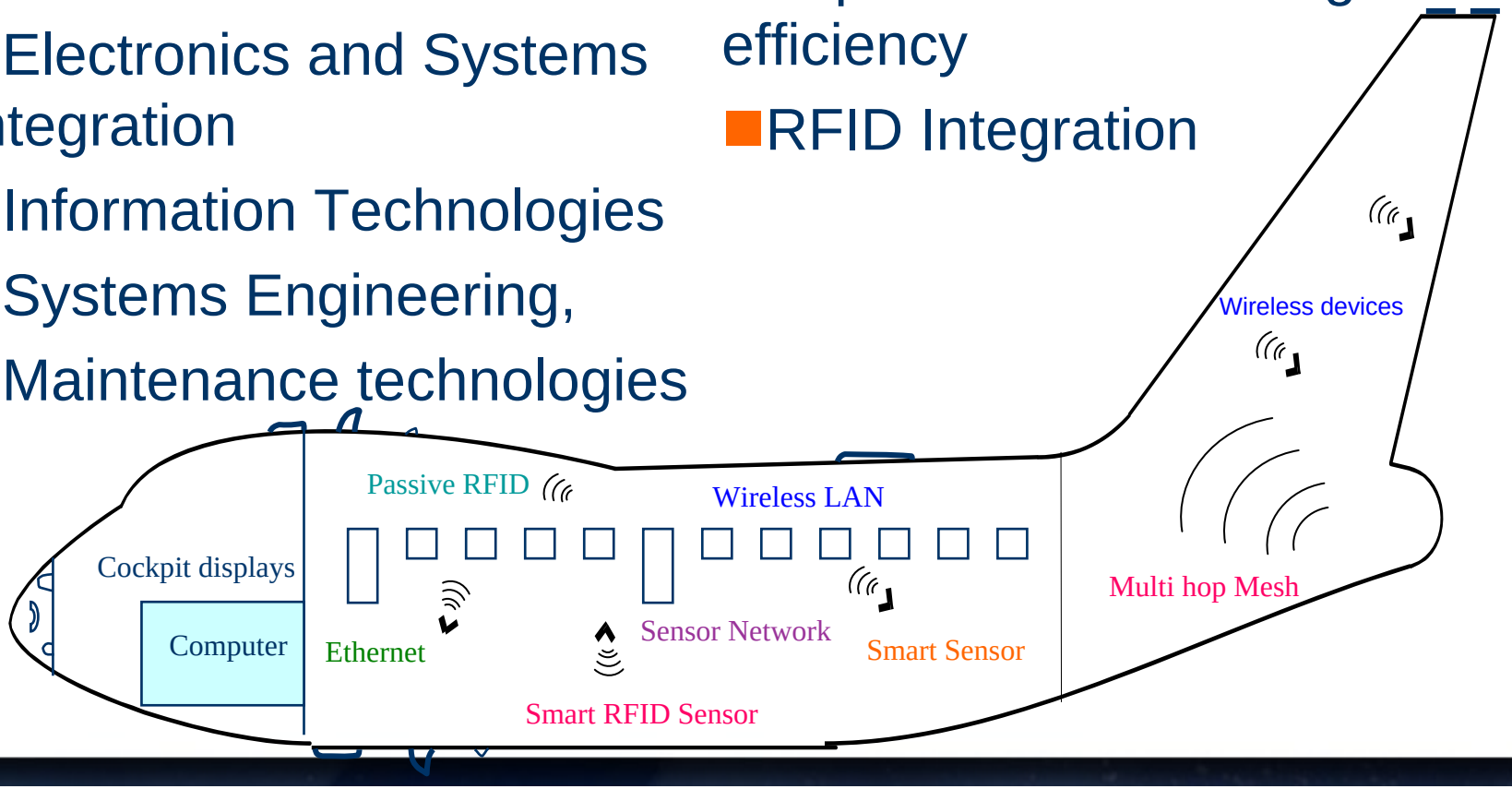
Product Lifetime **25-50 Years**	***Development of more robust technologies. Networked RFID solutions (product life cycle information 25 years.) Better product visibility during usage phase.***
Product Characteristics **Higher Value**	***Further development of higher value RFID technologies*** ***Semi Passive, Sensor enabled, Active.*** ***Integration of RFID systems with other data systems; Sensory systems, Aircraft systems.***
Application Areas **Product Usage Information**	***Some Logistics / Predominantly in the product usage phase*** ***Responsiveness of operations;*** ***Safety, Airline Operations, Aircraft health monitoring, Track & Trace, Maintenance Processes, Product Recalls, Refurbishment, Reuse, Recycling.***
Environmental Conditions **Harsh Operation Conditions**	***Further development of RFID technologies; RFID deployed in critical environments*** ***RFID Usage in harsh environments near (Metals/Chemicals)***

Embedded Smart RFID Sensor Systems Avionics

- Live-cycle costs
- Redundancy principles
- Dedicated solution, supplier specific
- Replacement issues
- Low part numbers, niche products, high costs
- Performance, low bandwidth
- Harsh environments
- Temperature variations

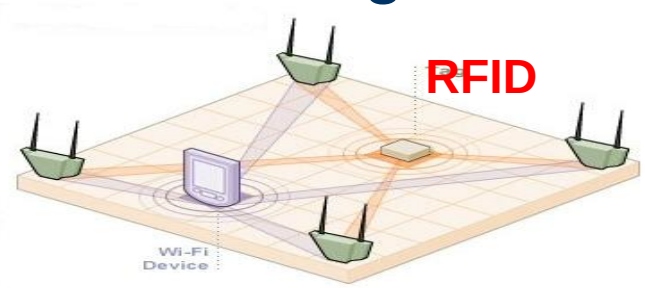
Distributed RFID and Wireless Smart Sensor Systems

- RFID Sensors
- Wireless communication
- Electronics and Systems Integration
- Information Technologies
- Systems Engineering,
- Maintenance technologies
- Sensor data collection
- Exploit moving nodes
- Exploit network coding for efficiency
- RFID Integration



Real Time Location Systems

- Intelligent long range active RFID systems to identify, locate and track assets at a distance of up to 100m and to deliver superior real time visibility in dynamic, demanding environments.
- Long range (100m) RFID tag not with read/write capability, and 360° visibility of wireless regardless of tag orientation.
- Features:
  - Sensor location layout map
  - Planned number of readers and access point antennas
  - Placement of active RFID Tags on the assets.



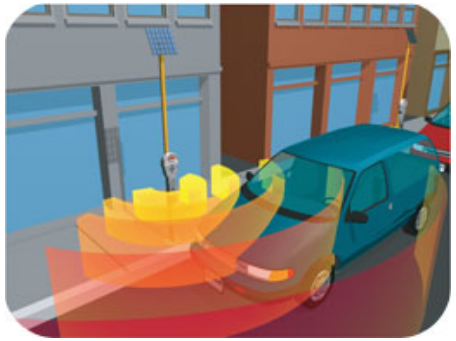
RFID for Traffic

- RFID derived position among vehicles (V2V)
- RFID for communication between the vehicle and infrastructure (V2I and I2V),
- LANE LEVEL position

http://www.compexinc.com/

Vehicle Identification System

- **Determine if a vehicle registration has expired.**
- **Monitor traffic and vehicle speed in construction zones or other pertinent areas.**
- **Ticketing parking.**



Lane level Accuracy in Urban Areas

- Collision avoidance
- Enhancement of driver's situation awareness
- Traffic signal priority for emergency and transit vehicles
- Traffic signal violation warning
- Lane change warning
- Stop sign movement assistant –Assessing which gaps are safe for driver
- Detection of approaching vehicles

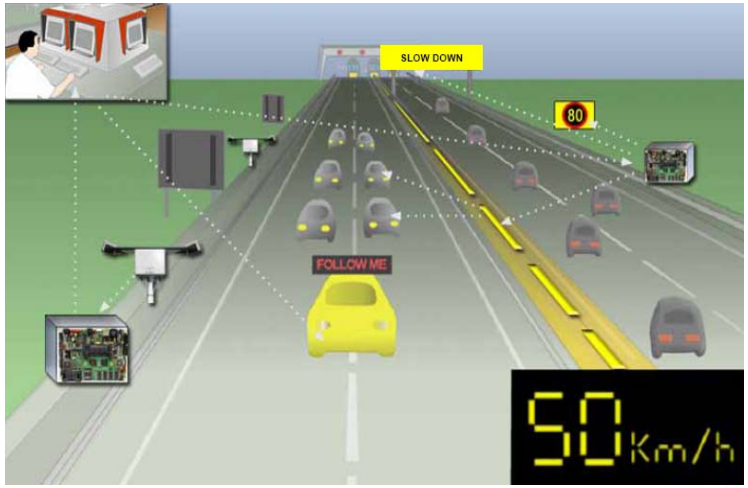
Lane level Accuracy in Urban Areas

- Congestion Mitigation -> Congestion pricing (High occupancy tolling lanes -HOT and TOT lanes. Price additional lane capacity)
- Incident and work zone management: Route vehicles off road or around incident LANE BY LANE
- Load balancing across lanes
- Alternative approach to the current loop detector
- Wireless communication to/from vehicles based on lane level position sensing
- RFID enables real time sensing of lane level vehicle position

RFID Vehicle Lane level positioning

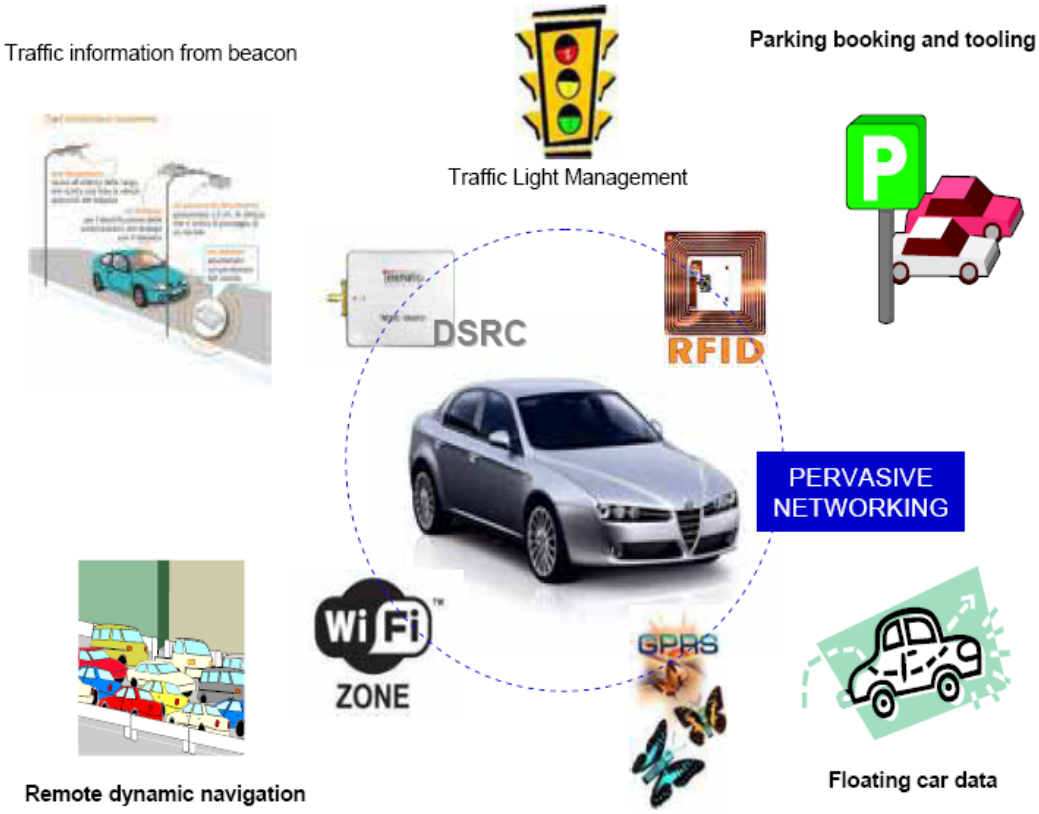
- RFID reader embedded i vehicle front bumper as part of electronic “license plate” type device
- Lateral field of view = 1 lane width
- Passive RFID tags down centre of lane/embed RFID tags in tape that replaces standard lane marking tape
- RFID tag stores the following information:
  - Road identifier
  - Lane identifier
  - Direction of travel identifier
  - Longitudinal distance from reference
  - Other relevant data

  (dependent on application)



RFID V2V and V2I

- Detection of pedestrian cyclists and bikers
- Calculation of the relati position of the vulnerab road users
- Detection of dangerous situation
- Actualization of the strategies of warning a intervention



- **V2V communication**

Further research

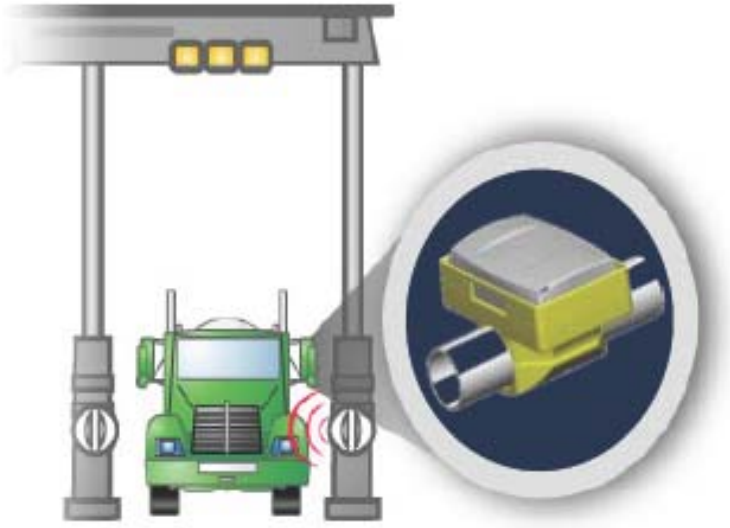
- RFID based vehicle positioning can be combined with V2V, V2I, I2V to enable VII applications
- Engineering and design issues: range, power, frequencies, environmental effects, robustness of tag and reader, noise immunity
- Applications dominated by supply chain logistics and asset/inventory management
  - Focus on improved efficiency
- Applications dominated by real time positioning and information accuracy
  - Focus on transportation safety and congestion mitigation applications.
- Interoperability

The „Internet of Things“

- Privacy Considerations:
  - Accountability
  - Purpose identified at time of collection
  - Informed consent for collection
  - Limited use and disclosure
  - Retention of data is limited
  - Quality of data (accuracy, completenes
  - Security of data
  - Openness about policies and practices
  - Individual access to data and correction

Security and Privacy

- Privacy Questions
  - Admissibility as evidence in court?
  - Release in “anonymized” form?
  - Accessible to insurance companies?
  - Transparency of process?
  - Who owns the data?
  - Can we trust the ….?



RFID Next Step

- End users have many choices (RFID-HF/UHF/MW, GPS etc.)
- Application of RFID can provide enhanced inventory visibility, and current methods and metrics must considered to determine business case
- Global activities
- Retailers and manufacturers are showing increasing interest in having providers supply RFID solution
- Collaboration with hardware and software providers to help understand industry's intricacies that can impact RFID deployment to assure operational viability

RFID Next Step

- Security and privacy protection schemes for inter enterprise sharing
- Standardization and adoption of business messaging and transaction protocols
- Rapid and cost-effective enterprise application integration
- Generalization for efficient internetworking as well as specialization to support domain specific applications, such as product and food safety, cargo security
- Client-side technologies for low-cost, reconfigurable and easy deployment of network application functions
- Real-time data and mobile solutions for time-critical requirements, such as air freight forwarding, trucking and courier delivery.

RFID Next Step

- Integration of RFID, e-seal, GPS or RF positioning, wireless communication and environmental sensors for application use
- Interoperability among e-seal technologies, information platforms, regional and global standards for truly global coverage for containerized logistics
- Application scenarios referenced from cases such as cross border customs clearance, quarantine-required logistics traceability, secured transportation, storage security, asset management, logistics tracking and route monitoring, and innovations in advanced e-seal applications

RFID Next Step

- Integration of key functions such as identification (e.g. RFID) and sensor data (e.g. temperature, humidity, vibration, etc) in logistics operations.
- Tools to facilitate the development of track-and-monitor logistics applications.
- Information delivery infrastructure for the tracking data, e.g. RFID to 3G, GPRS, TCP, Wi-Fi, GPS, etc
- Algorithms and methodologies for handling information security, integrity and transfer of the sensor data for privacy and auditing requirements

The RFID Movement

Which side are you on?