La Trobe University

Melbourne, Australia

IPv6 - Application in Home/Industrial Automation

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Presentation Outline

- **Overview of IPv6**
  - IPv4 and its limitation
  - IPv6 and its advantages
- **Applications of IPv6**
  - Home
  - Industry
  - Intelligent Transport Systems (ITS)
  - Grid Computing
  - Mobile Terminal
- **Centre for Technology Infusion**
  - Model
  - Industry Development Facilities

Internet Protocol

Transports a datagram from source host to destination, possibly via several intermediate nodes ("routers")

Service is:

- **Unreliable**: Losses, duplicates, out-of-order delivery
- **Best effort**: Packets not discarded capriciously, delivery failure not necessarily reported
- **Connectionless**: Each packet is treated independently

IP Network Addressing

- INTERNET → world's largest public data network, doubling in size every nine months
- Traditional model of classful addressing does not allow the address space to be used to its maximum potential
- IPv4, defines a 32-bit address - 2^{32} (4,294,967,296) addresses
- The concern is the eventual depletion of the IP address space

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Problems with IPv4

- Limited Address Space
  - IPv4 has 32 bit addresses
- Routing Table Explosion
  - IP does not permit route aggregation (limited super-netting possible with new routers)
- Header Limitations
- Lack of quality-of-service support.
  - Only 8-bit ToS field, which is hardly used
- Mobility support is limited.

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IPv6: Improved Features

- Header format simplification
- Expanded addressing and routing capabilities
- Improved support for options
- Flow labeling (for QoS) capability
- Auto-configuration and Neighbor discovery
- Authentication and privacy capabilities
- Simple transition from IPv4

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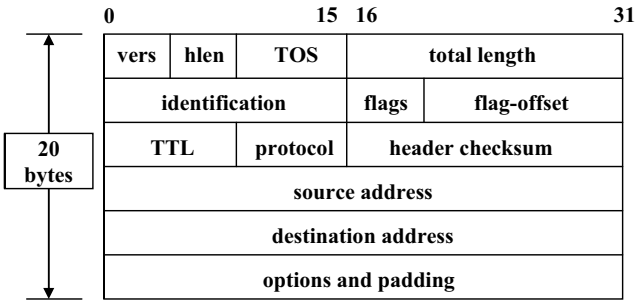
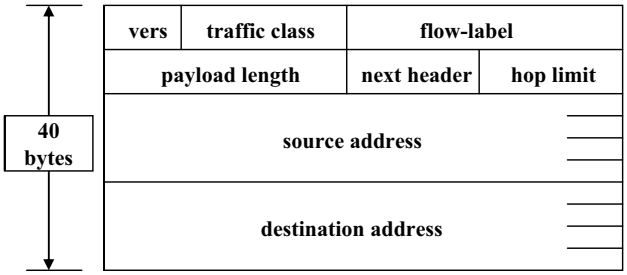
Header comparison



IPv4



IPv6

Removed

- ID, flags, flag offset
- TOS, hlen
- header checksum

Changed

- total length => payload
- protocol => next header
- TTL => hop limit

Added

- traffic class
- flow label

Expanded

- address 32 to 128 bits

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Major Improvements of IPv6 Header

- No option field: Replaced by extension header. Result in a fixed length, 40-byte IP header.
- No header checksum: Result in fast processing.
- No fragmentation at intermediate nodes: Result in fast IP forwarding.

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IPv6 Routing

- Hierarchical addresses are to be used
- Longest prefix match routing to be used. (Same as IPv4 routing under CIDR)
- OSPF, RIP, IDRP, etc. will continue as is (except 128-bit addresses)
- Provider selection possible with anycast groups

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QoS Capabilities

- Protocol aids QoS support, not provide it.
- Flow labels
  - To identify packets needing same quality-of-service
  - 20-bit label decided by source
  - Flow classifier: Flow label + Source/Destination addresses
  - Zero if no special requirement
- Traffic class
  - 8-bit value
  - Routers allowed to modify this field

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IPv6: Security

- Provision for
  - Authentication header
    - Guarantees authenticity and integrity of data
  - Encryption header
    - Ensures confidentiality and privacy
- Encryption modes
  - Transport mode
  - Tunnel mode
- Independent of key management algorithm
- Security implementation is mandatory requirement in IPv6

Mobility Support in IPv6

- Mobile IPv6 allows a node to move from one link to another without changing the address
- Movement can be heterogeneous, i.e., node can move from an Ethernet link to a cellular packet network
- Mobility support in IPv6 is more efficient than mobility support in IPv4
- There are also proposals for supporting micro-mobility

IPv6

Applications

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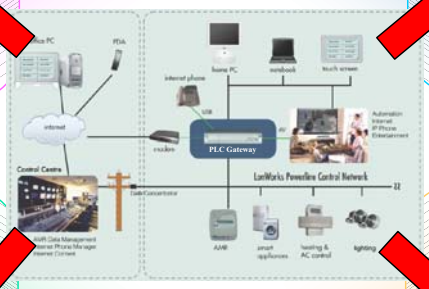
Home/ Industry Automation Application

Home Networking
- IPTV service
- VoD service
- Internet access
- Printer sharing
- AV network
- Home security

Communication Solutions
- Internet Access
- VoPL (VoIP over PLC)
- Office Network
- Network device



Technologies

Industry Solutions
- Business Admin. System
- Factory Automation
- Control Network
- Sensor Networks
- Video Surveillance System
- Office network

Utility Solutions
- AMR
- Transformer Monitoring
- Facility Diagnostics
- Int. Distribution Sys.
- Power Quality Mentoring
- Demand Management

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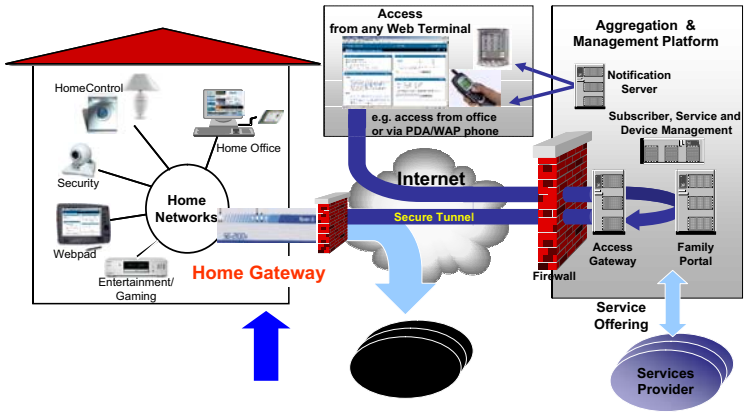
Current Network Protocol Requirement

- Communication infrastructure for home automation is currently based on
  - PLC/BPL
  - Wireless/wired
  - iRFID
  - etc
- Network complexity is increasing
- Require efficient network protocol



Source: IBM

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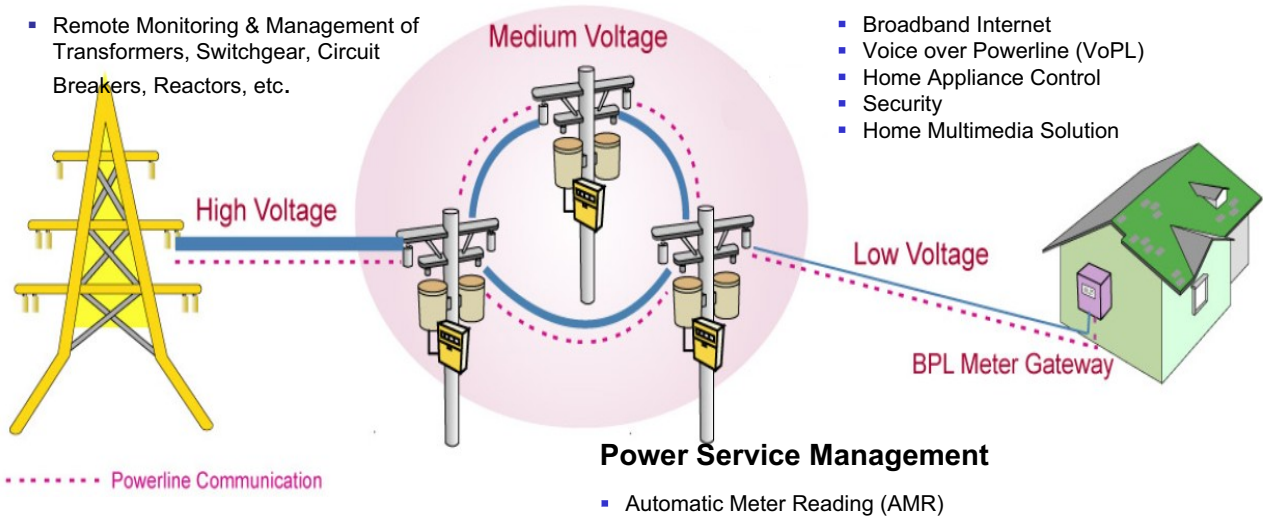
BPL/PLC Applications

Power Grid Management

- Remote Monitoring & Management of Transformers, Switchgear, Circuit Breakers, Reactors, etc.

Home Network Infrastructure

- Broadband Internet
- Voice over Powerline (VoPL)
- Home Appliance Control
- Security
- Home Multimedia Solution



Power Service Management

- Automatic Meter Reading (AMR)
- Integrated AMR (water, gas, electricity)
- Real-Time Pricing
- Load Management
- Power Quality Management

Distributor — End Use

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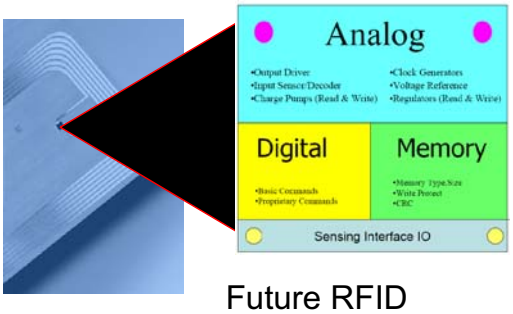
Intelligent RFID (iRFID)

- **Current RFID Network**
  - Allows remote tracking and identifying of object
  - Tags respond to readers with a unique identity
- **Future RFID Network**
  - Incorporates diverse and distributed hardware, data and logic to enable process automation
  - Acts as low cost remote sensor network
  - **Features**
    - Distributed data and logic
    - Relationships between components
    - Coordination between devices, antennas
    - Automatic information capture and management
    - Employment of Wireless Sensor network (WSN)

Current RFID



Future RFID

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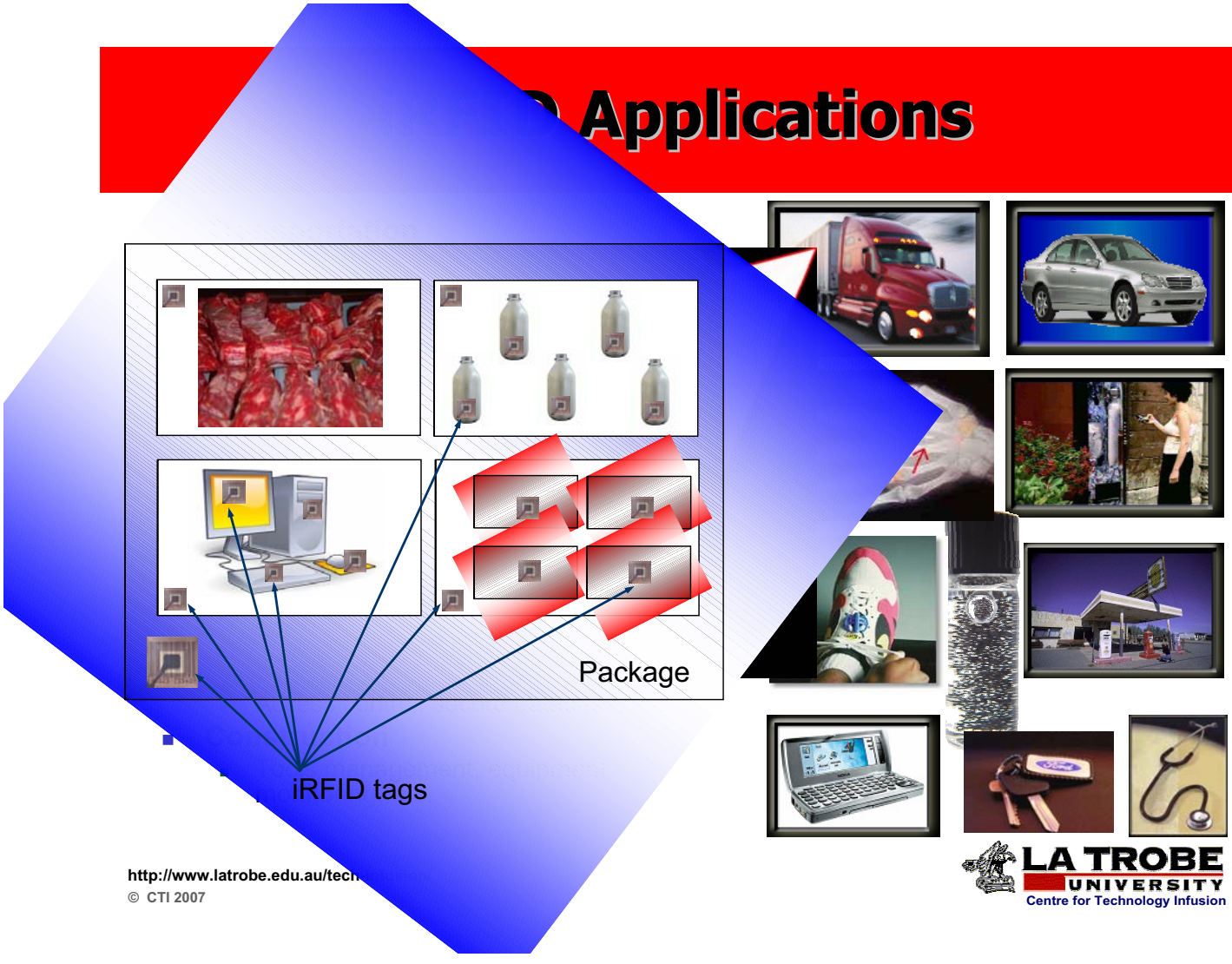
http://www.latrobe.edu.au/tech-infusion/

Applications



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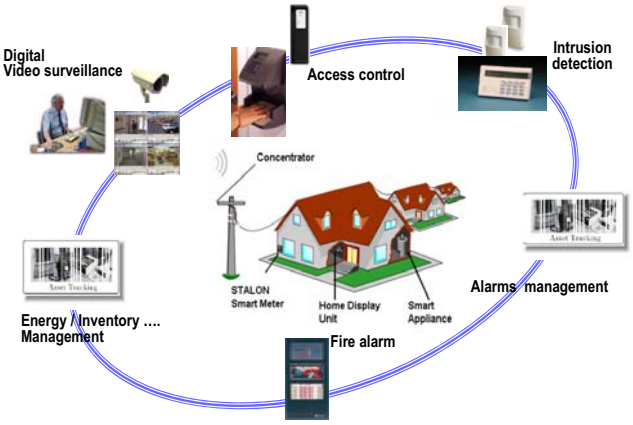
Requirement – Efficient Network Protocol - IPv6

- Larger Address Space
- Efficient backbone routing
- Efficient and Extensible IP datagram
- Stateless Address Auto configuration
- Security
- Mobility
  - Simplified IPv6 header format
  - Redundant header options dropped
  - Simple instant-on ad-hoc networking
  - Mobile IP, without servers, without dogleg
- QoS
- Plug and play



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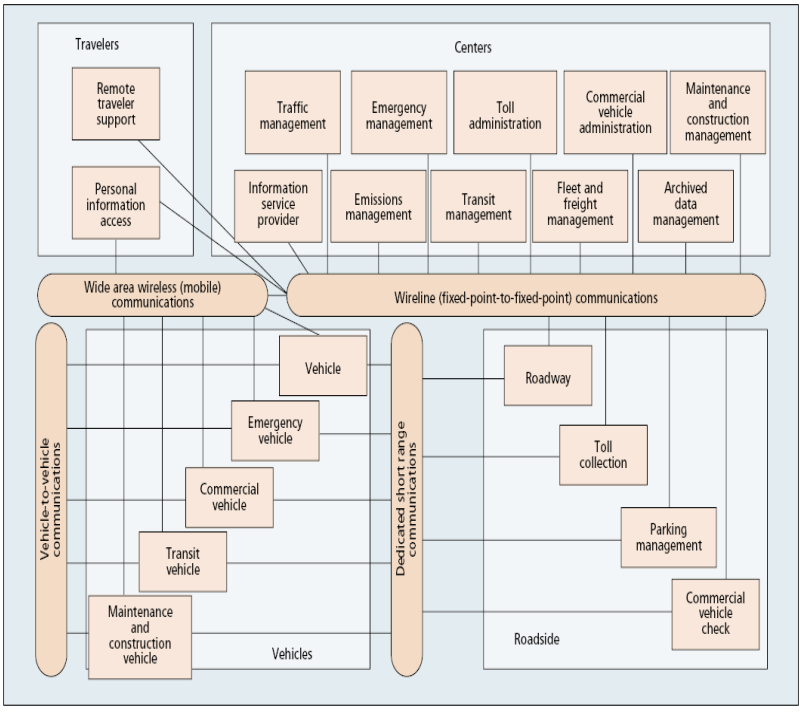
Intelligent Transport Systems (ITS)

- **ITS** – vehicle-to-vehicle, to roadside, to Centre, to travellers, etc
- **Safety**
  - Intersection collision warning, emergency vehicle approach warning, road hazard warning, etc
- **Information: "Roadside Kiosk"**
  - Traffic advisory, road construction, weather conditions, upcoming exit services, map updates, etc.
- **Internet Access Hot-Spots**
  - Provided by service stations, truck stops, retail store parking lots, etc.
- **Fleet Management**
  - Port of entry, asset tracking, security, scheduling
- **Electronic Payment**
  - Toll plazas, service stations, drive-through venues, truck stops, etc.



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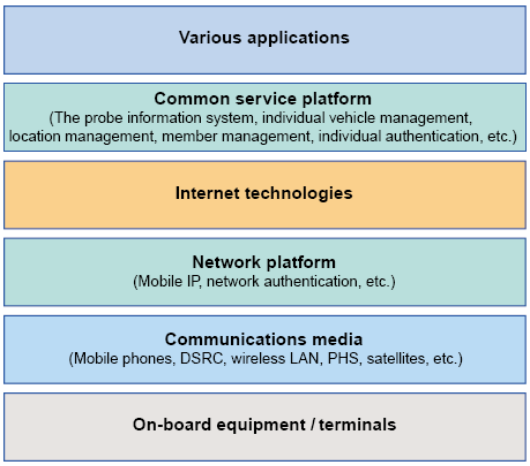
Intelligent Transport Systems (ITS)

- **Requirements**
  - Increasing Flexibility and Interoperability of sensors, terminals, data collection, network points.
  - Cost to Benefit Ratio
  - Road Safety and Efficiency
  - Security in Portable Environments
  - Seamless Content Synchronous Solutions



Source: NEC

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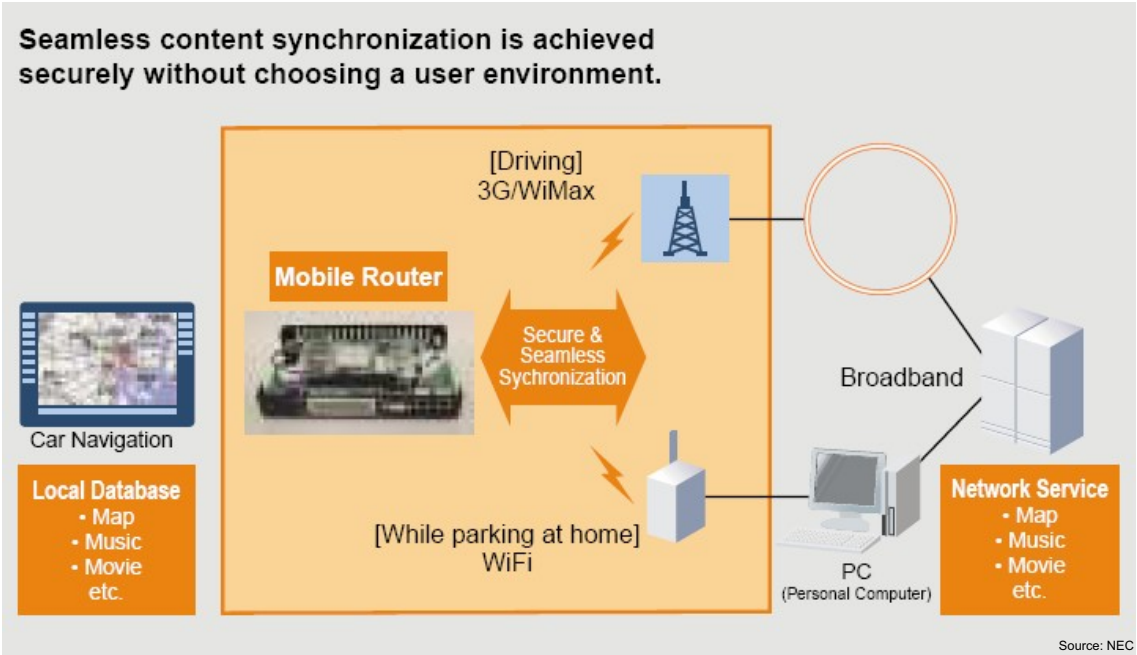
Intelligent Transport Systems

Cross network connection and Mobile IP



Source: NEC

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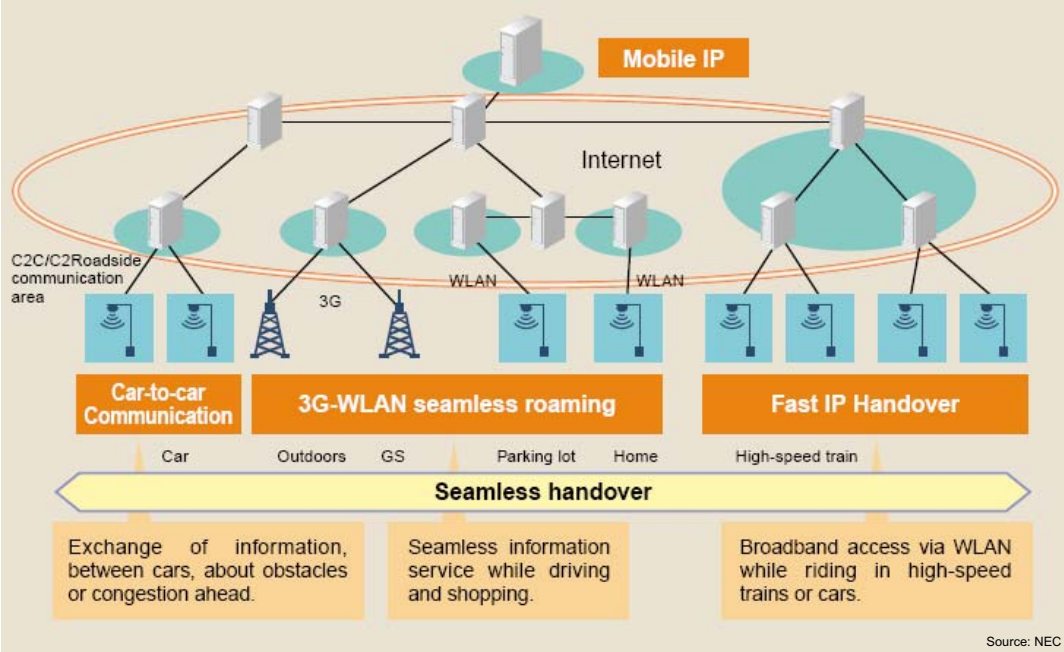
ITS and Mobile IP



- **Extended Security and Privacy**
- **Improved Quality of Service and Redundancy**
- **Efficient Routing**

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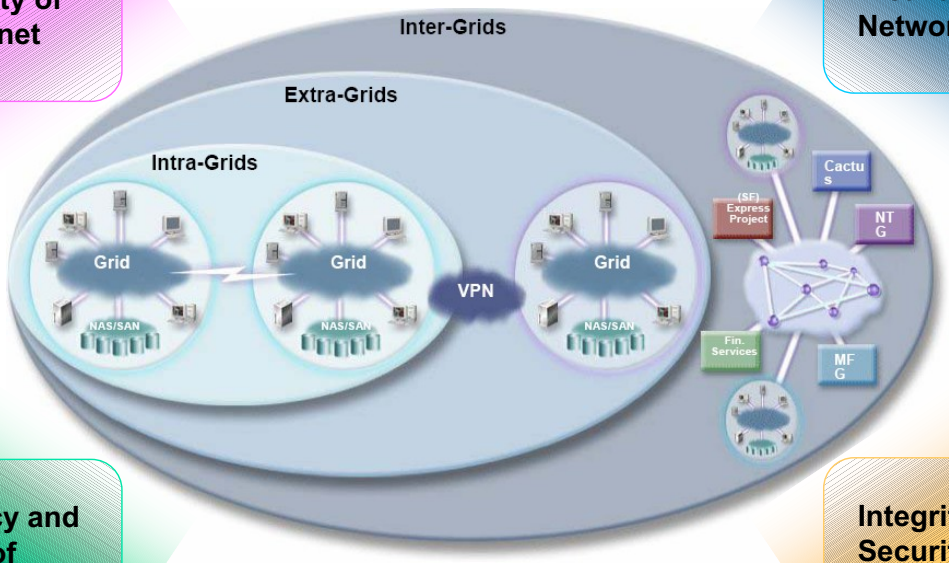
Grid Computing

Scalability of the Internet

Heterogeneous Distributed Networks



Efficiency and Quality of Service

Integrity and Security Over Networks

Source: Ian Foster, IBM

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Grid Computing and IPv6

- Enabling new applications based on resource virtualization
- IPv6 will enable existing and new generation virtual grids to span existing network boundaries
- Potential for massive scaling
- Uniform global address space can eliminate ambiguous private addresses and network address translation
- Wasteful proxies can be avoided creating clean network connectivity
- Network level security can be implemented efficiently
- Auto-configuration in IPv6 can simplify extension and configuration of infrastructures in virtual grids

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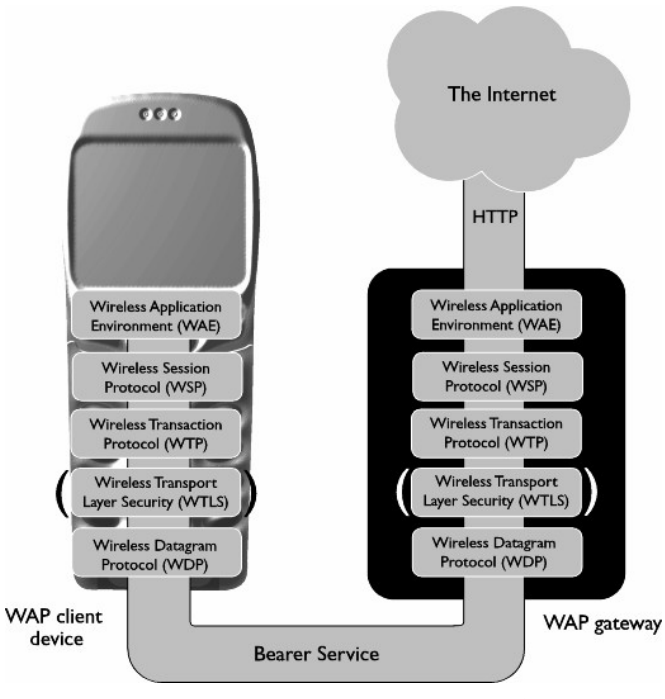
Mobile Terminals

- **Device Providing**
  - Limited address space
  - Fractured Networks with private addresses and NAT
- **Application Services**
  - With IPv4-NAT devices cannot easily act as servers with incoming connections to offer services
- **Workarounds like Application Level Gateway (ALG)**
  - Extra Cost for protocol design and complexity in service deployment
  - No end-to-end transparency complicates security issues
  - Lost scalability with custom solutions



Source: www.kannel.org

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Mobile Terminals

- **Clean networking:** Devices can enable internet connections without need for NAT
- **Plug-and-Play:** With growing number of devices with diverse range of capabilities – auto-configuration with IPv6 is indispensible.
- **Security:** Ability to use end-to-end IPsec as there is no requirement for NAT
- **Mobile IP:** Mobile IPv6 does not require foreign agents and Internet-wide IPv6 mobility management can be provided by running a home agent anywhere on the Internet. IPv6 Internet access and mobility management can be provided by separate entities - building and maintaining costly access networks is not a requirement for providing mobility
- **Extensibility:** Unforeseen requirements of the future can be incorporated easily with architecturally clean extensibility of IPv6

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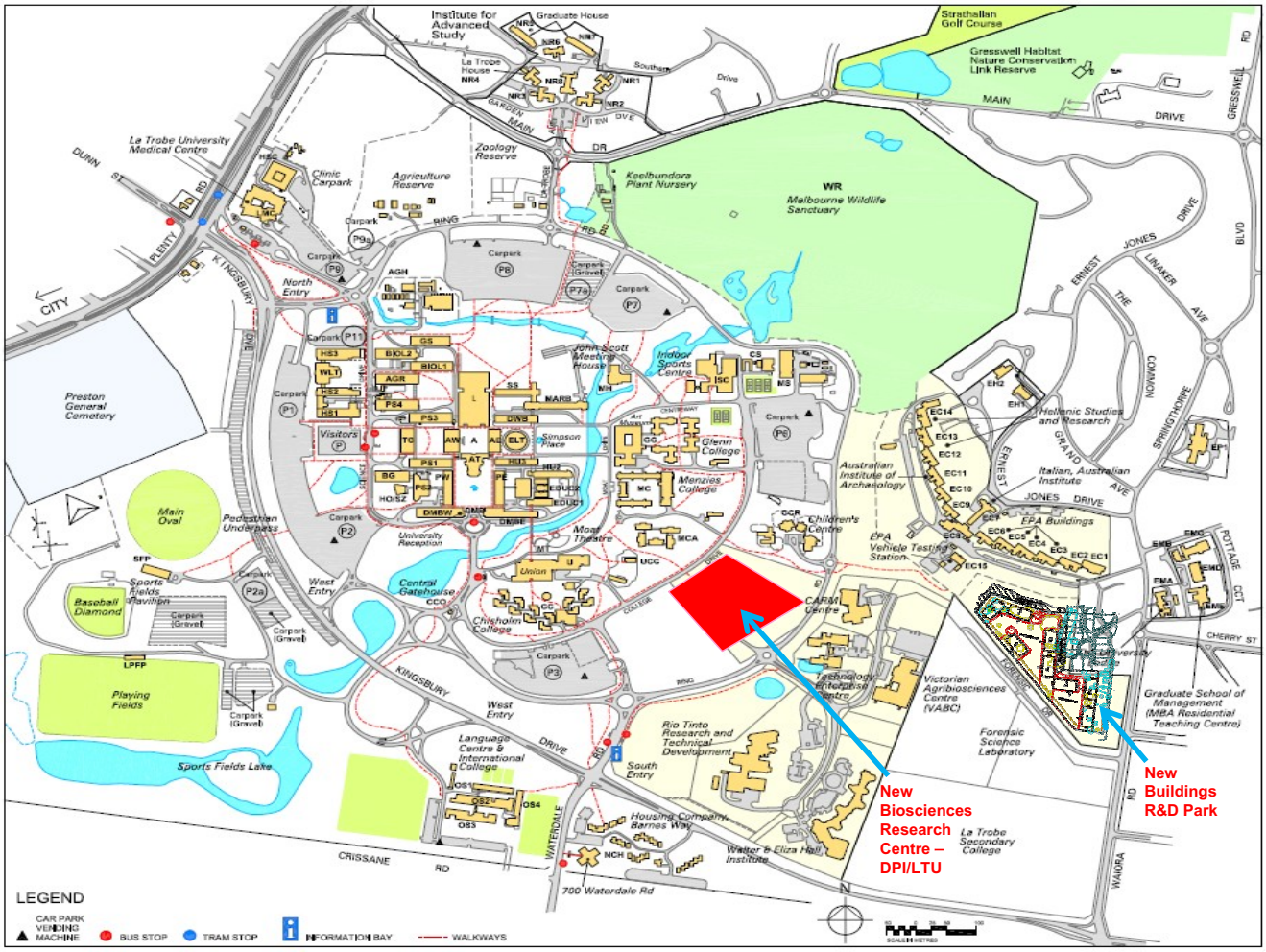

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Fostering High-Tech Knowledge Transfer

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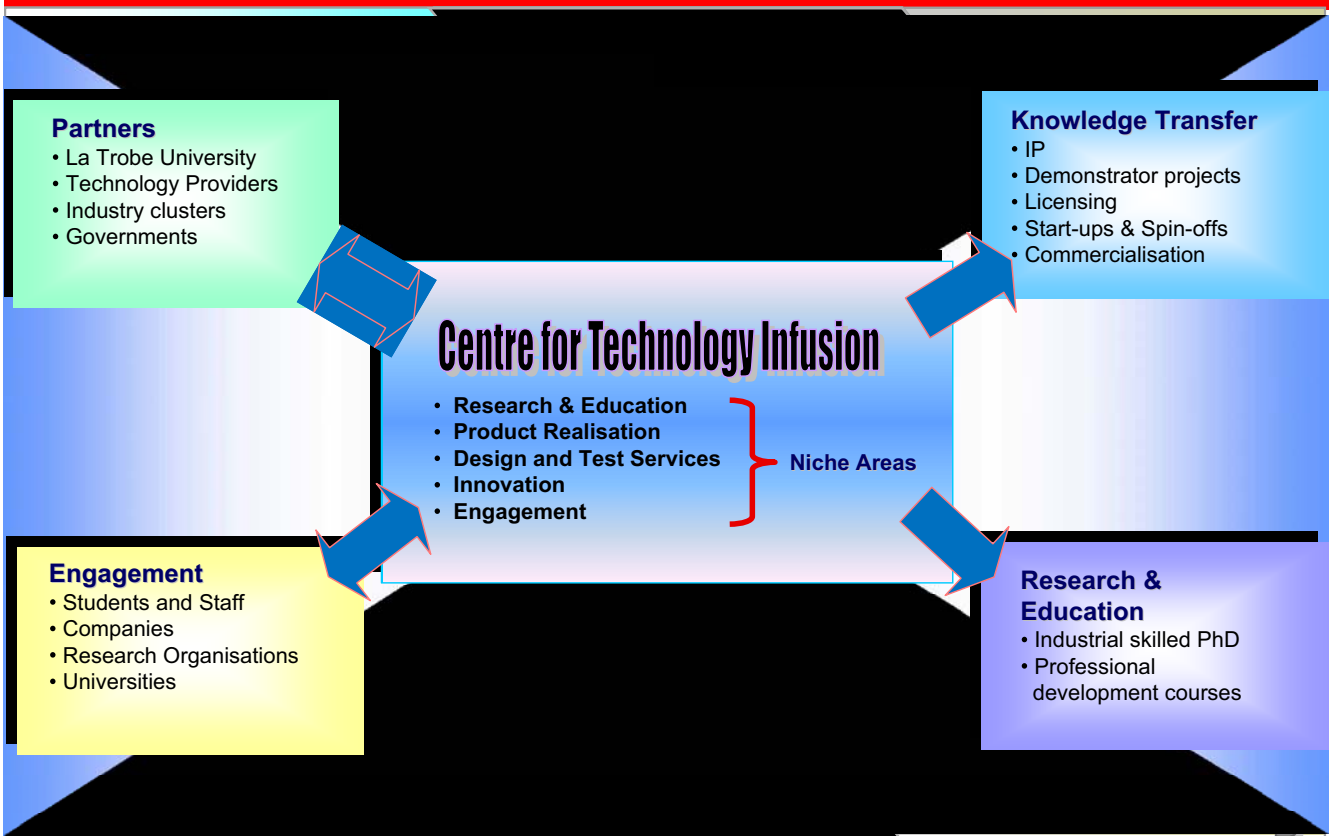
Knowledge Transfer
MODEL



Microsoft Centre

- Microsoft, La Trobe University .Net industry cluster
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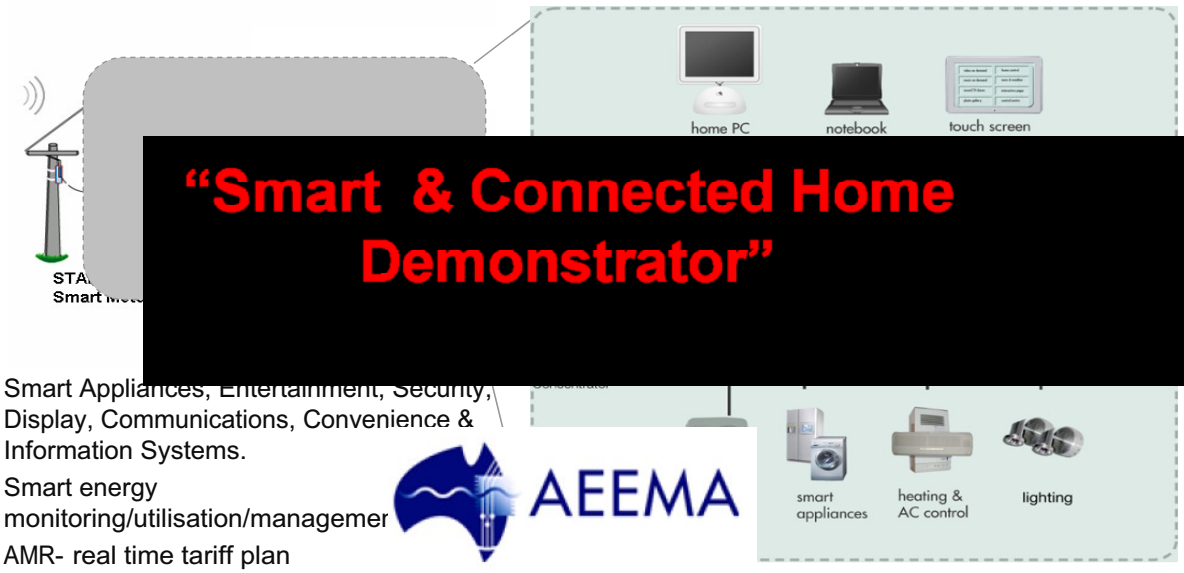
Microsoft LA TROBE UNIVERSITY victoria NET i-mate WACOM intel

"Smart Home" Centre

Access to cutting-edge technology & simulating environment for research & innovation



"Smart & Connected Home Demonstrator"

- Smart Appliances, Entertainment, Security, Display, Communications, Convenience & Information Systems.
- Smart energy monitoring/utilisation/managemer
- AMR- real time tariff plan
- Connectivity – convergence of technologies (PLC, BPL, Wireless, RFID, Embedded, IPv6)

AEEMA

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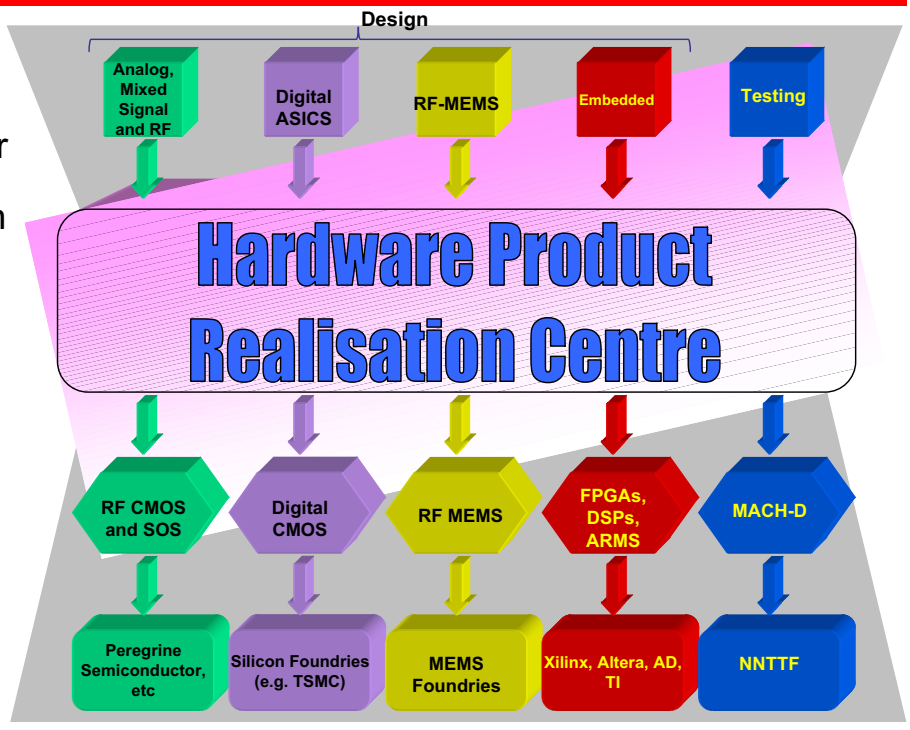
Hardware Product Realisation Centre

- Technologies, Design tools, infrastructure and methodologies for product realisation and commercialisation
- Provision of design and test services
- Support L&T, Research, innovation & knowledge transfer in:
  - Telecommunication
  - Health Care
  - Environment & Energy
  - Transportation
  - Defence



Sun microsystems · NNTTF · COVENTOR · cadence · Peregrine Semiconductor · ALTERA · LA TROBE UNIVERSITY

National Networked Tele Test Facility for Integrated Systems

- Access to $15 million Major National Research & Commercialisation Facility
- Nodes in Victoria, South Australia, Queensland, Western Australia & NSW
- Facility for
  - Testing System-on-Chip (SoC)
  - Validation
  - Characterisation

Conclusion

- IPv4 has been remarkably resilient, but there is a growing shortage of IPv4 addresses
- IPv6 has enabled the next generation of applications due to its new and simplified IP header, new and expanded addressing architecture and improved support for IP options
- IPv6 approach can be efficiently deployed in future complex network