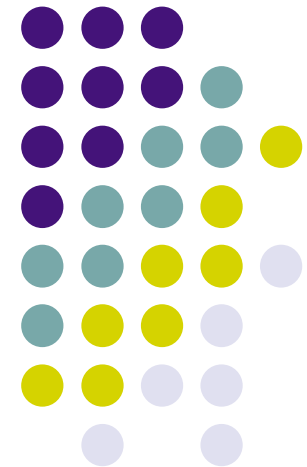


# Emerging IPv6 Applications

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# Today's Internet



- Enabled by the underlying Internet Protocol
- Until recently, two “killer applications”
  - Web
  - E-mail
- Internet users are consumers
  - Connect to Internet servers from own networks
  - Fetch web pages, fetch or send email messages
- ISPs and content providers offer services
  - Consumers (users) access those services
- Limited access to user-provided services
  - Due to current Internet Protocol (IPv4) limitations

# Vision



- Using Internet technology for better
  - Exploring, understanding, playing, learning, ...
- Ubiquitous access to information (knowledge)
  - Home networking (access **into** the home)
  - New networking scenarios (e.g. vehicle networks)
  - New types of devices (e.g. sensors)
- Interacting with our environment
  - With seamlessly integrated computer devices
  - Underpinned with advanced networking infrastructure
- IPv6 as a key enabler of the vision

# Some enablers of the vision



- Architecture buzzwords:
  - Peer-to-peer (p2p)
  - Semantic web services
  - Knowledge technologies
  - Agent-based computing
  - Ambient intelligence
  - GRID computing
- Hardware technology:
  - Wireless LAN
  - Bluetooth
  - RFID tags
  - Wearable computers
  - Embedded systems
  - Sensor networks
- Underlying Network
  - Internet Protocol
  - **IPv6**

# Peer-to-peer (p2p) computing



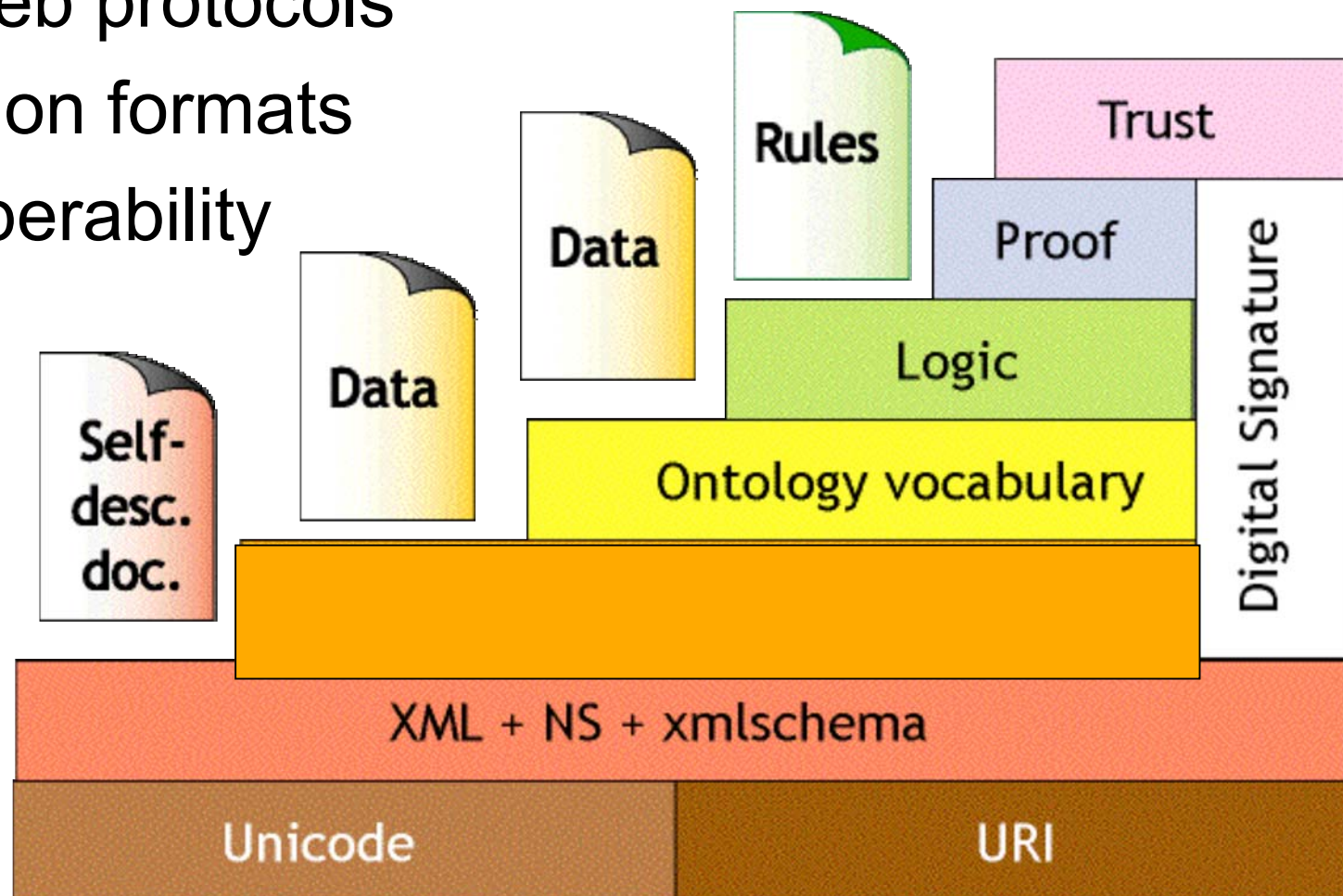
- User-to-user device-to-device communication
  - Emerging “killer app”
- Direct, bypassing intermediary servers
  - Requires all networked devices be addressable
- Examples:
  - File-sharing - popularised by Napster, etc.
  - Instant messaging
  - Voice over IP (VoIP)
- Currently usually provisioned by intermediaries due to limitations of the IPv4 protocol



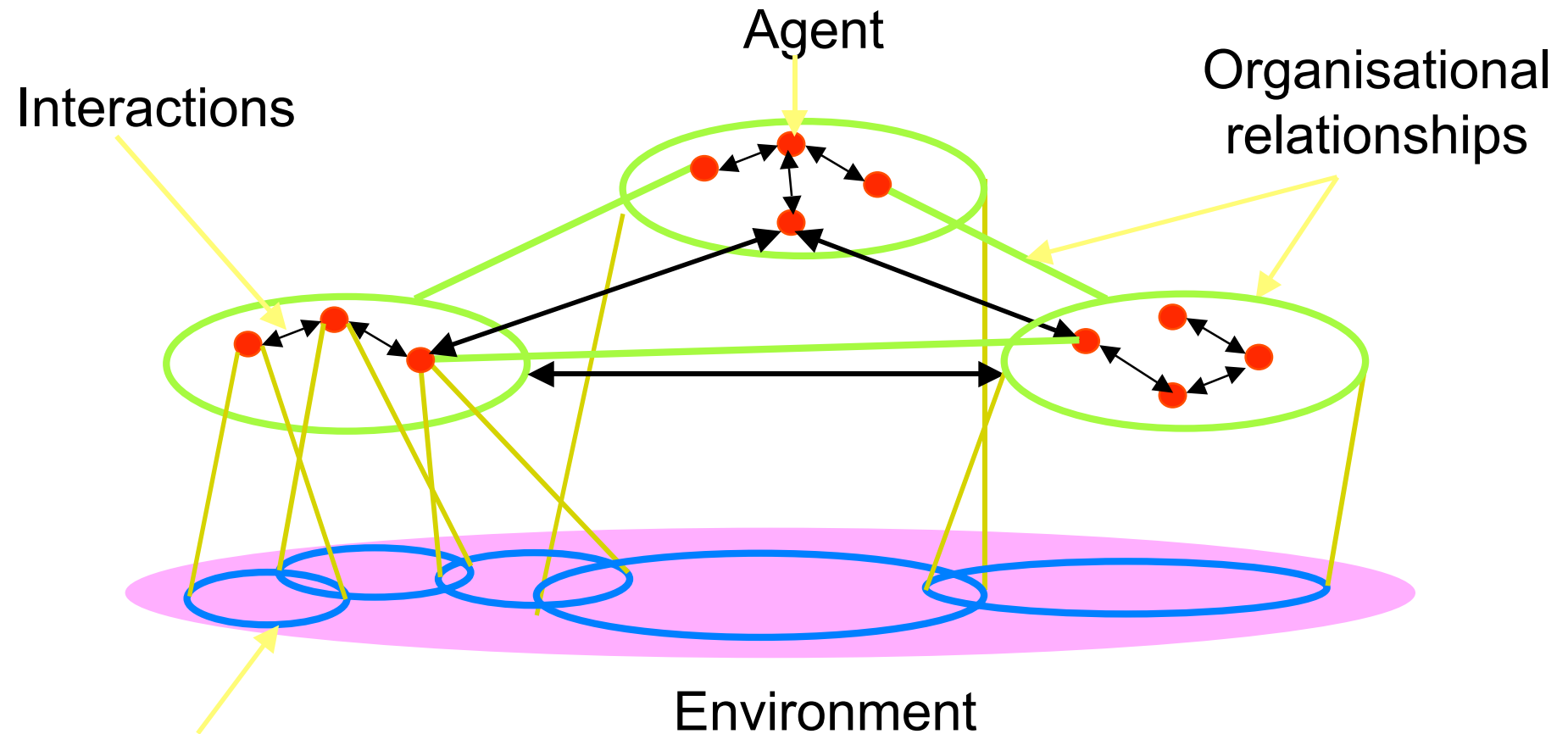
# Semantic web services



- Use web protocols
- Common formats
- Interoperability



# Agent-based technology



# Ambient intelligence



- Info Society today
  - PC-based
  - “Writing and reading”
  - “word”-based searches
  - Low bandwidth networks
  - Mobile telephony (voice)
  - Micro scale
  - e-Services emerging
  - Less than 10% online
- Future Info Society
  - Surroundings is interface
  - Use all senses, intuitive
  - Context-based handling
  - High bandwidth, convergence
  - Mobile/wireless multimedia
  - Nano scale
  - Wide adoption (e-Health, learning, ...)
  - World-wide adoption



# GRID



- GRID is a new view on distributed computing
  - Using available (potentially idle) computer (CPU) power
  - Using network links between the computers to distribute data for computations
  - Distributing tasks to multiple processors
  - Implies remote processes/computers are addressable
  - May require synchronous processing of multiple streams of incoming data
- Usually requires authentication and security
  - Control access to resources
  - Many development frameworks (e.g. Globus)

# Wireless networking

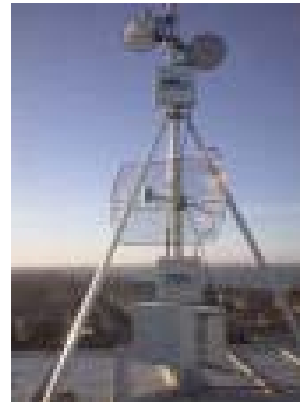


- Growing fast in parallel areas
  - Telco provision - GPRS, 3G, ...
    - Wide coverage, but expensive
  - Public spectrum Wireless LAN (“WLAN” or “Wifi”)
    - Data rates up to 50Mbit/s where available
    - Focused into local “hotspots” (e.g. campus, airport, ...)
  - Personal, short-range local communications
    - Bluetooth (“room local”)
- New faster wireless technology coming
  - All devices must be addressable

# Now: Community WLAN



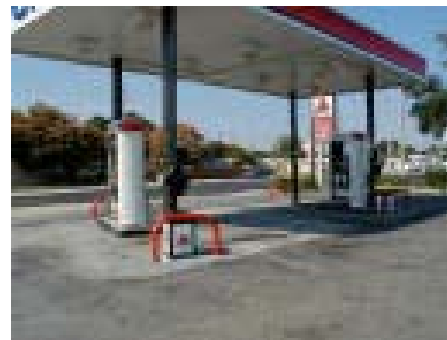
- Networking for communities
  - Often rural, remote locations
  - Point-to-point links, mesh networking
- Includes academic outreach
- People become self-empowered
  - Share local resources
  - Be accessible remotely



# Soon: Wireless on the road



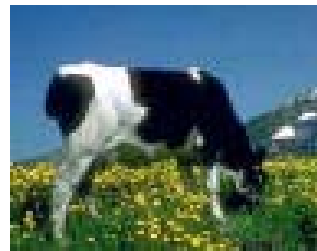
- Opportunistic connectivity
- Ad-hoc networking
  - At home in garage
  - At petrol stations
  - Car-to-car (c2c)



# RFID



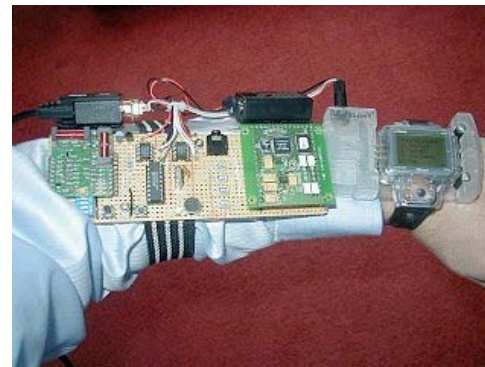
- A tag with a unique identifier
  - Very short range radio signal
- RFID reader may be IP-enabled
- Can trace tagged objects
  - e.g. farm livestock
  - Implies privacy issues
- Cost falling
  - Sub-Euro



# Wearable computing



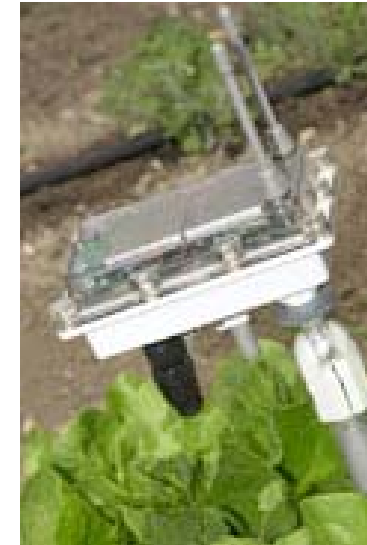
- PDA-like devices
  - Lightweight
  - Low power
  - Eye (HUD) display
  - Wireless networking



# Environmental sensors



- Pervasive computing in the environment
- Many application scenarios
  - Earthquake prediction
  - Global warming monitoring
  - Flood plain monitoring
  - Glacial drift measurement
- Technology
  - Radio based sensors
  - IP-based monitoring, real-time or periodic
  - Remote processing of data





# Floodnet



- UK DTI-funded project (in East Anglia)
- Monitoring
  - Trend analysis
- Predictions
  - Early warning





# GlacsWeb



- Also DTI funded
  - Measure drift
  - Extreme location



# GlacsWeb



- Issues:
  - Robustness
  - Temperature
  - Power
  - Wireless data
  - Deploy and forget



# IPv6?



- What does it offer us?
  - Globally unique Internet Protocol address space for huge variety of new IP-enabled applications
    - Implies support for more “always-on” services
  - Autoconfiguration - network “plug and play”
  - Better support for communication with mobile devices on the Internet
    - Ad-hoc and mobile networks
  - Greater potential for end-to-end security
- Enables Internet growth
  - Billions of IP-enabled devices, in all walks of life

# Physical meets Digital

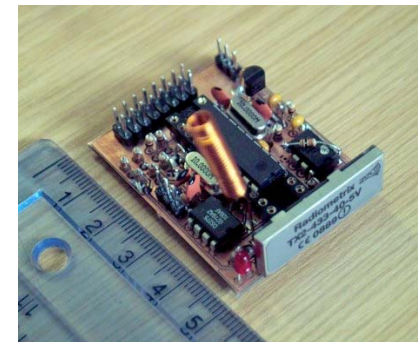
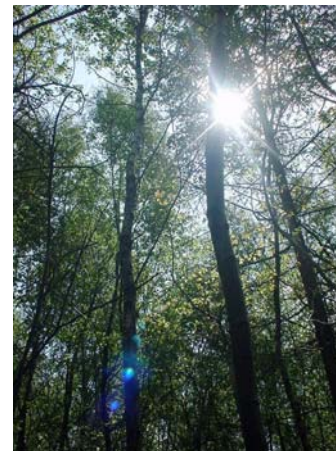


- Blurring the line between virtual and real worlds
  - For recreation or working environments
  - Local or remote interaction
- A combination of technologies in this talk
- Requires:
  - Adaptive infrastructures
  - Understanding interaction models
  - Embedded systems and devices
  - “The disappearing computer” to become reality
  - Underlying, scalable network technology
  - Globally addressable devices

# Ambient wood project



- Playful learning for kids
  - Sensors - radio pingers/probes
  - Tangibles - objects with RFID
  - Interfaces - PDAs
  - Infrastructure - speakers

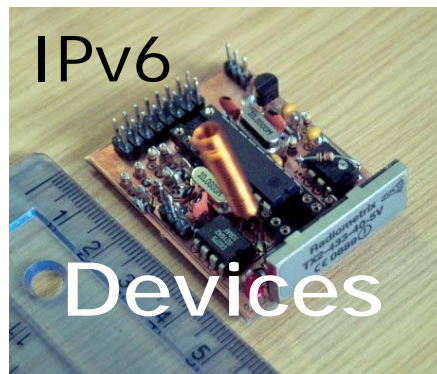




# Sensors meet GRID



- GRID computing used to distribute the sensor output analysis task, possibly real-time
  - For example for Floodnet



Model of floodplain

Can we shift the computation  
towards the devices?

# Medical sensors meet GRID



- Use of GRID-based medical devices for everyday health
  - Wearable monitoring systems
  - Wireless communications
  - Intelligent analysis, early warning
  - Remote IP-enabled monitoring



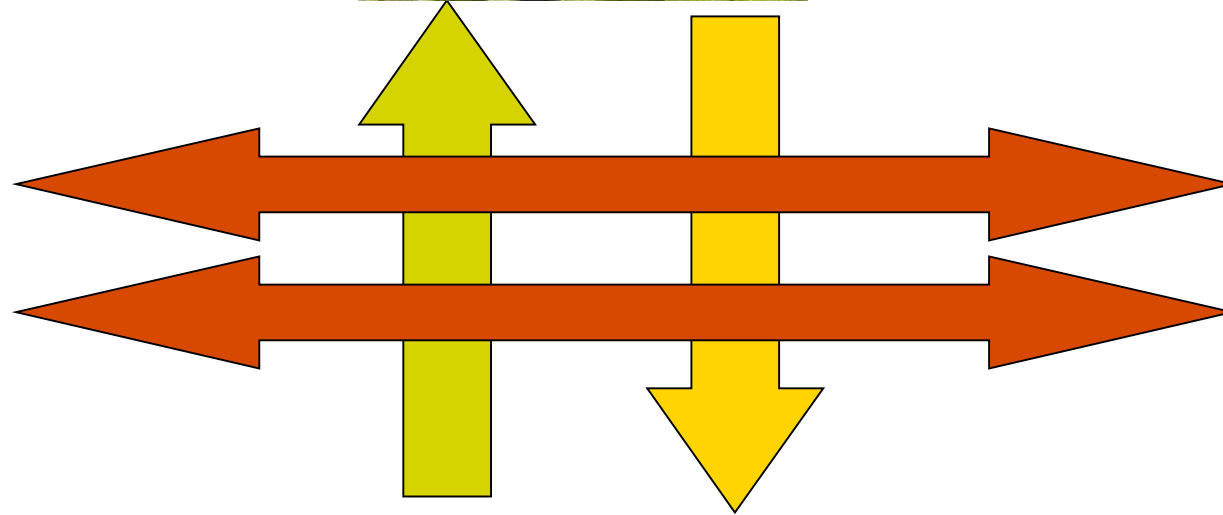
# Model:



Adaptive  
infrastructures



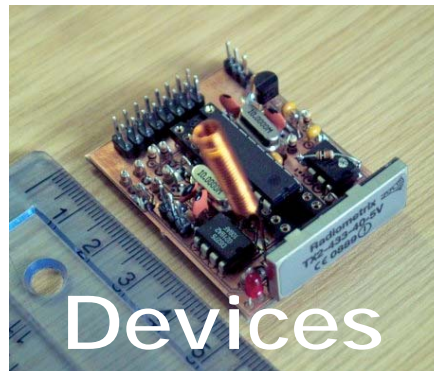
Users



Agents

Grid

IPv6



Devices



# The path ahead



- Many issues ahead, e.g.:
  - Deploying interoperable systems & components
    - Semantics, web services, ontologies
  - Further efficiencies
    - Reducing size and cost of components
    - Low power for low-cost networked devices
  - Security, trust and privacy issues
  - Scalability, innovation, device-to-device
- Using IPv6 as an enabling protocol
  - Global addressing, mobility, ad-hoc, plug-and-play

# References



- EU IPv6 Research
  - [www.ist-ipv6.org](http://www.ist-ipv6.org)
- EU IPv6 Task Force
  - [www.ec.ipv6tf.org](http://www.ec.ipv6tf.org)
- IPv6 Forum
  - [www.ipv6forum.org](http://www.ipv6forum.org)