Supporting Nomadic Agent-based Applications in the FIPA Agent Architecture

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Introduction

- Multi-agent system implementing a middleware providing (agent-based) applications with tools for adaptation in a nomadic environment
- Nomadic environments enable new ways to access services

  $\rightarrow$ anywhere, at any time, and using any device
- Challenges that need to be addressed:
  - Varying QoS of the wireless networks
  - Limitations of mobile devices
  - Contextual variability (location, time, user preferences, ...)

- Adaptation to the environment is the key issue

Presentation Outline

- Agent Architecture for Wireless World
  - Based on FIPA's architecture
- Ontologies for Wireless World
  - What kind of ontologies are needed
  - Examples
- Agent Communication for Wireless World
  - Layered model & optimization techniques

Agents?

Never send a man to do a machine's job
- agent Smith, Matrix

Wireless/Nomadic Environment

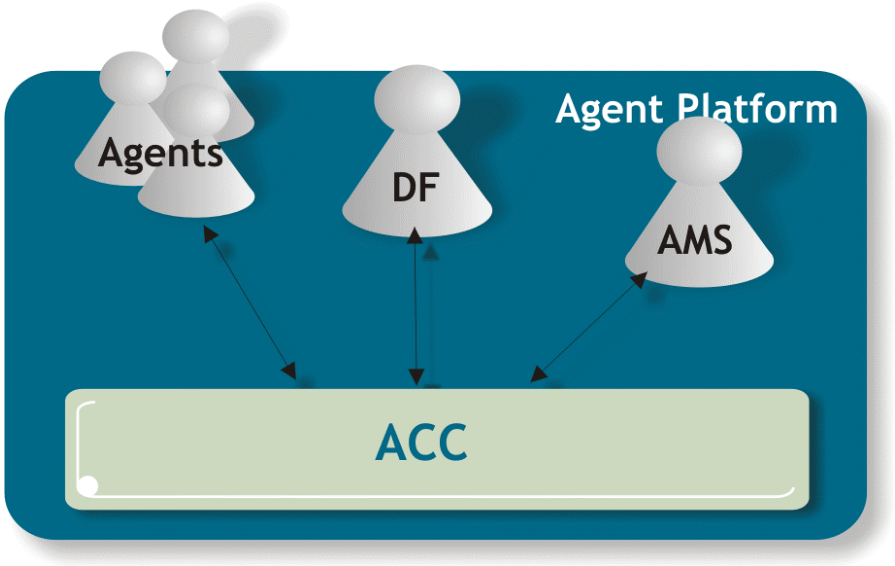
- Typical characteristics
  - Low throughput, long delays, unreliable, ...
    - *Variability*
  - Disconnected mode of operation is the most common state
- Different kind of (wireless) networks
  - Seamless roaming will be important in the future
- Currently we consider long thin networks
  - GSM, HSCSD, GPRS, UMTS, ...

Agents in Nomadic Environments?

- Suitable for complex environments
  - Internet is a complex environment...
  - Wireless Internet is even more complex...
  - Invisible Internet...

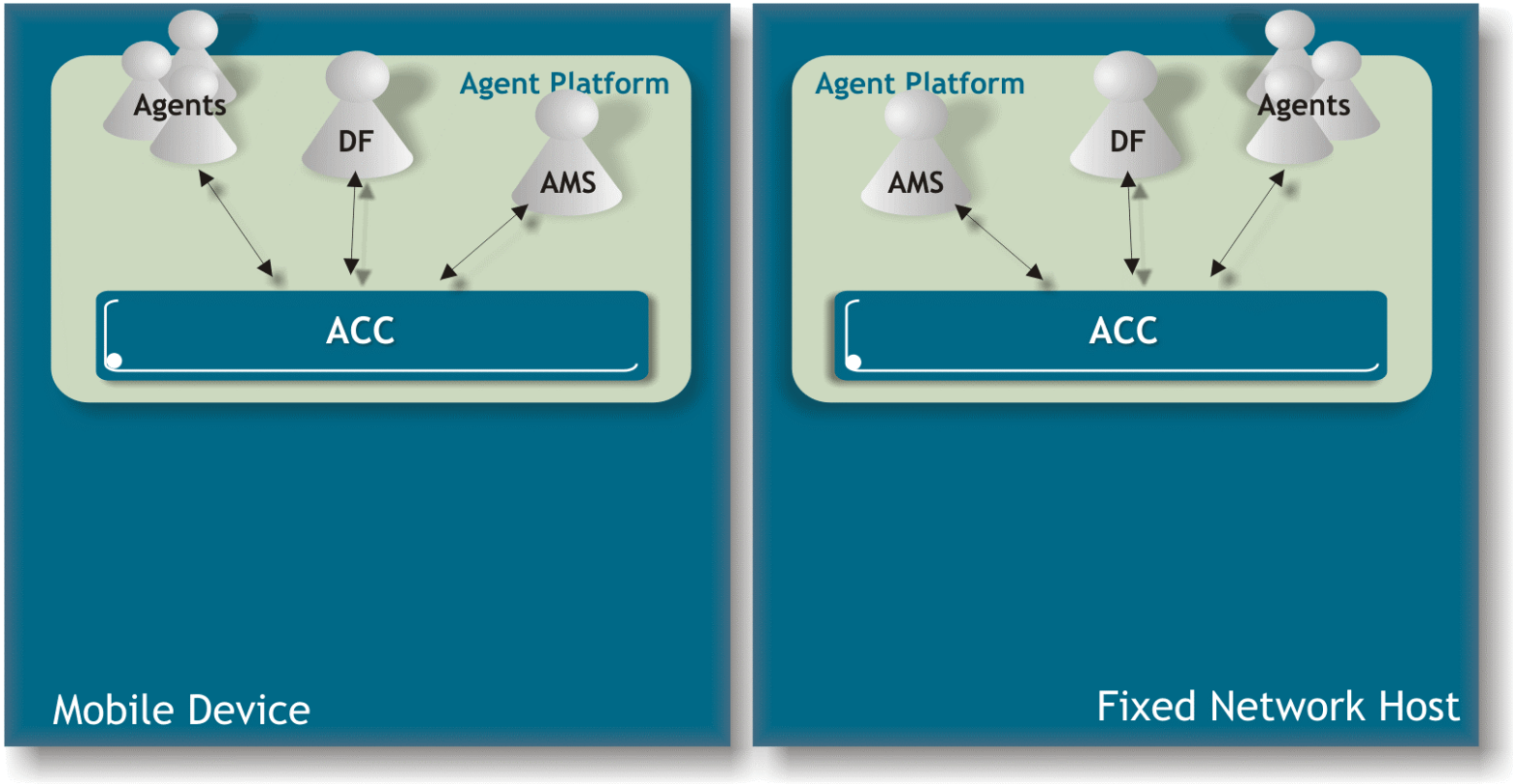
Agent Architecture in Wireless World

FIPA Agent Platform

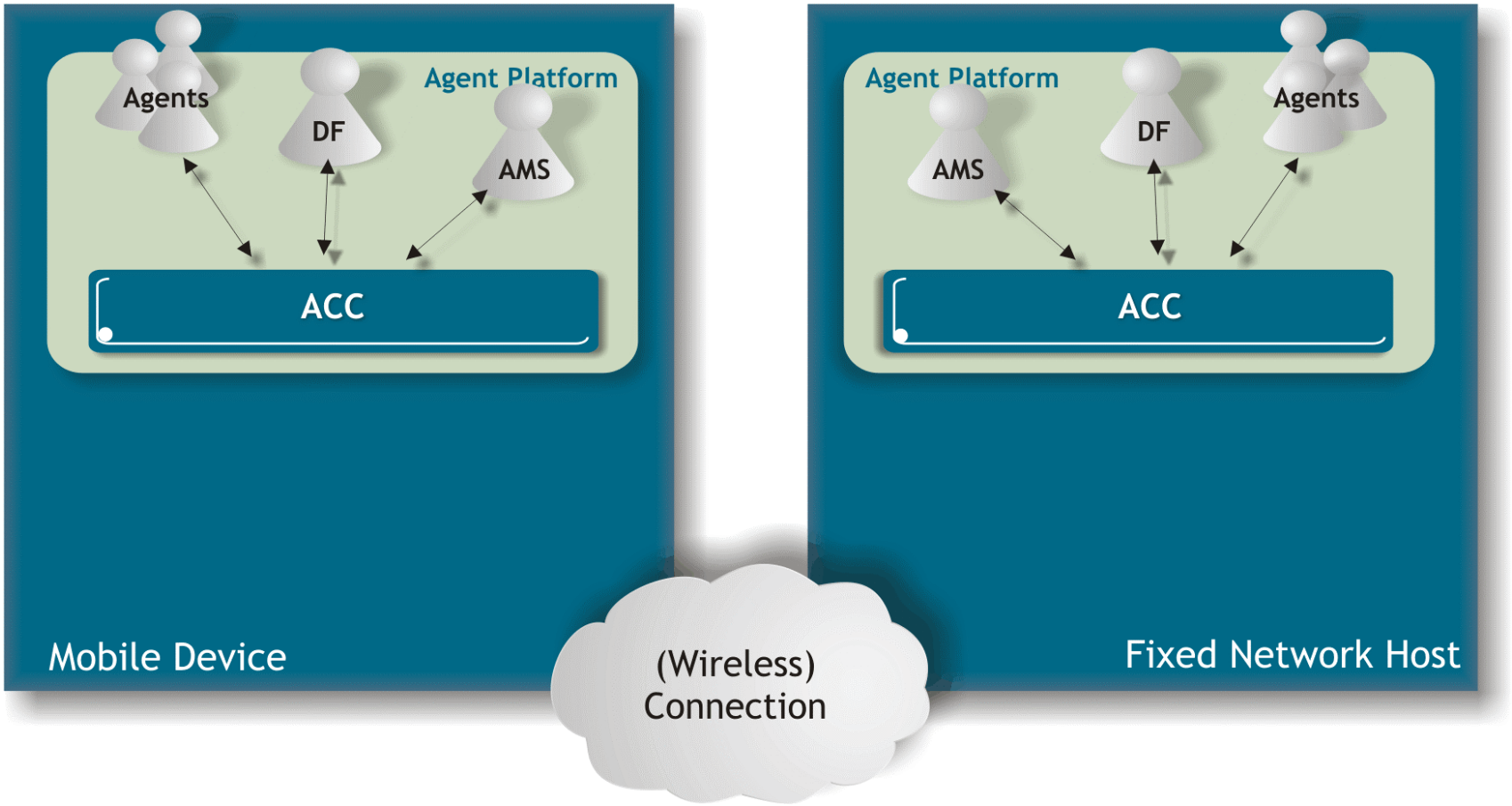


DF = Directory Facilitator
AMS = Agent Management System
ACC = Agent Communication Channel

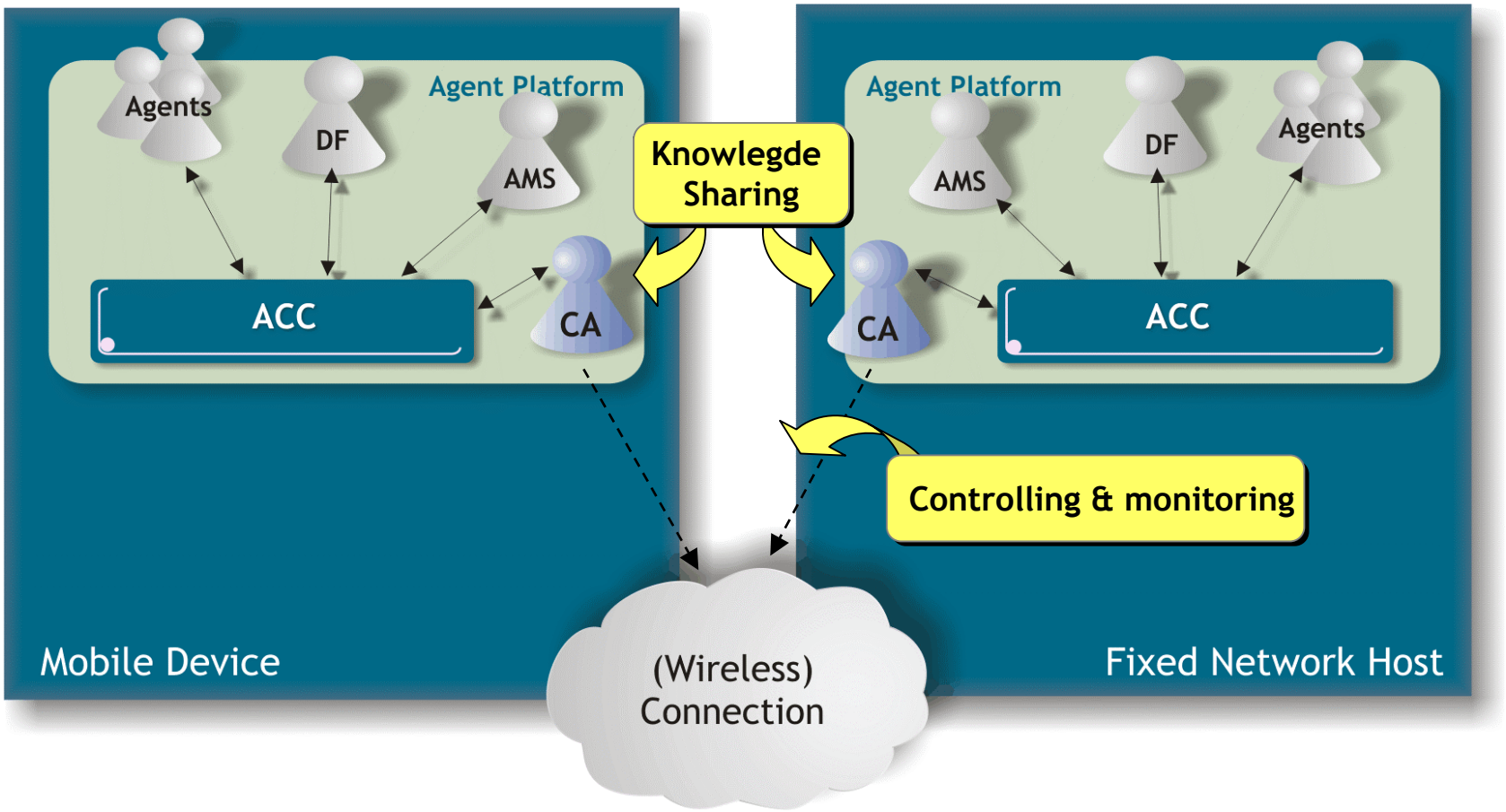
FIPA Agent Platform



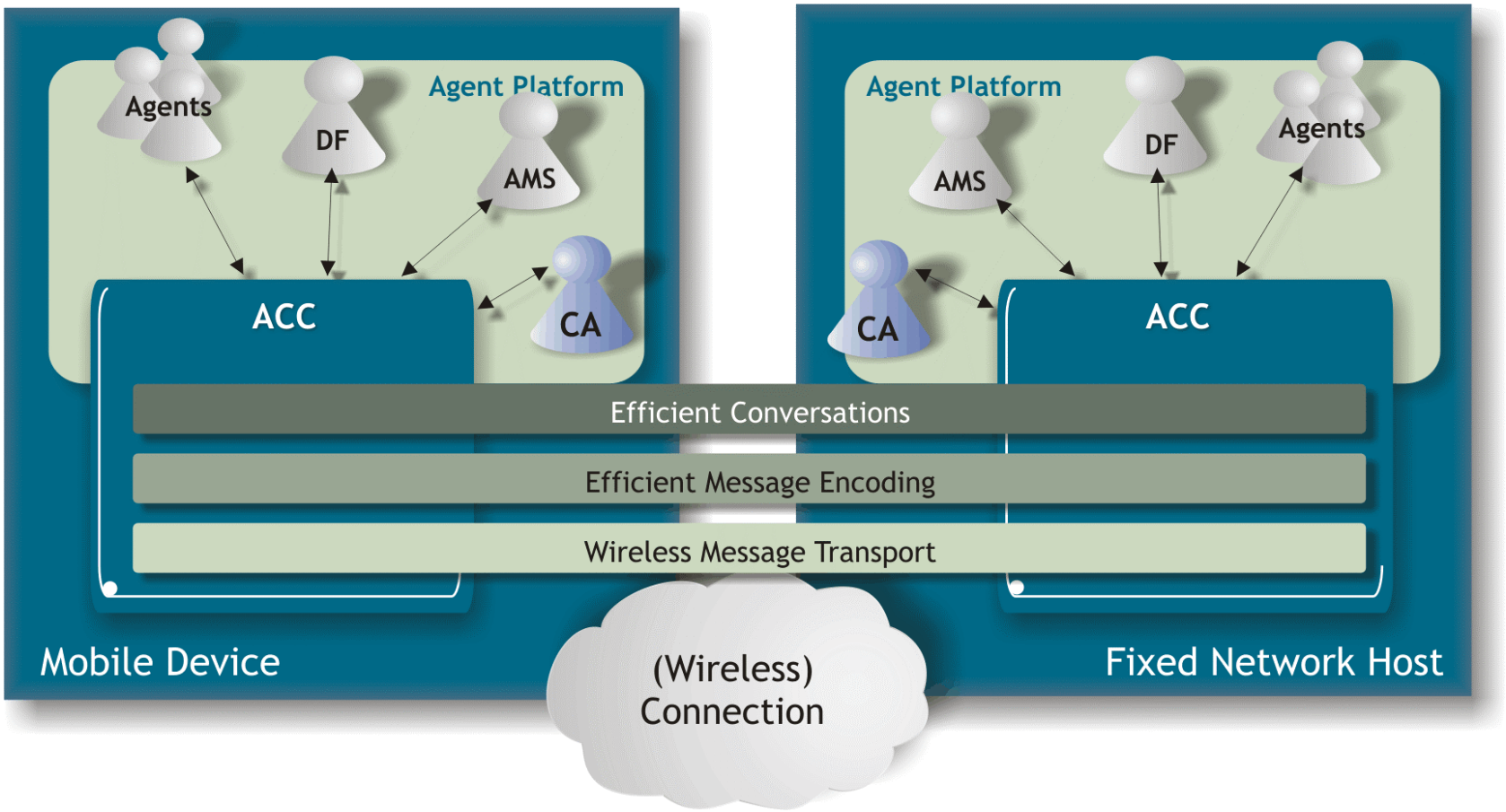
FIPA Agent Platform



FIPA Nomadic Application Support



FIPA Nomadic Application Support



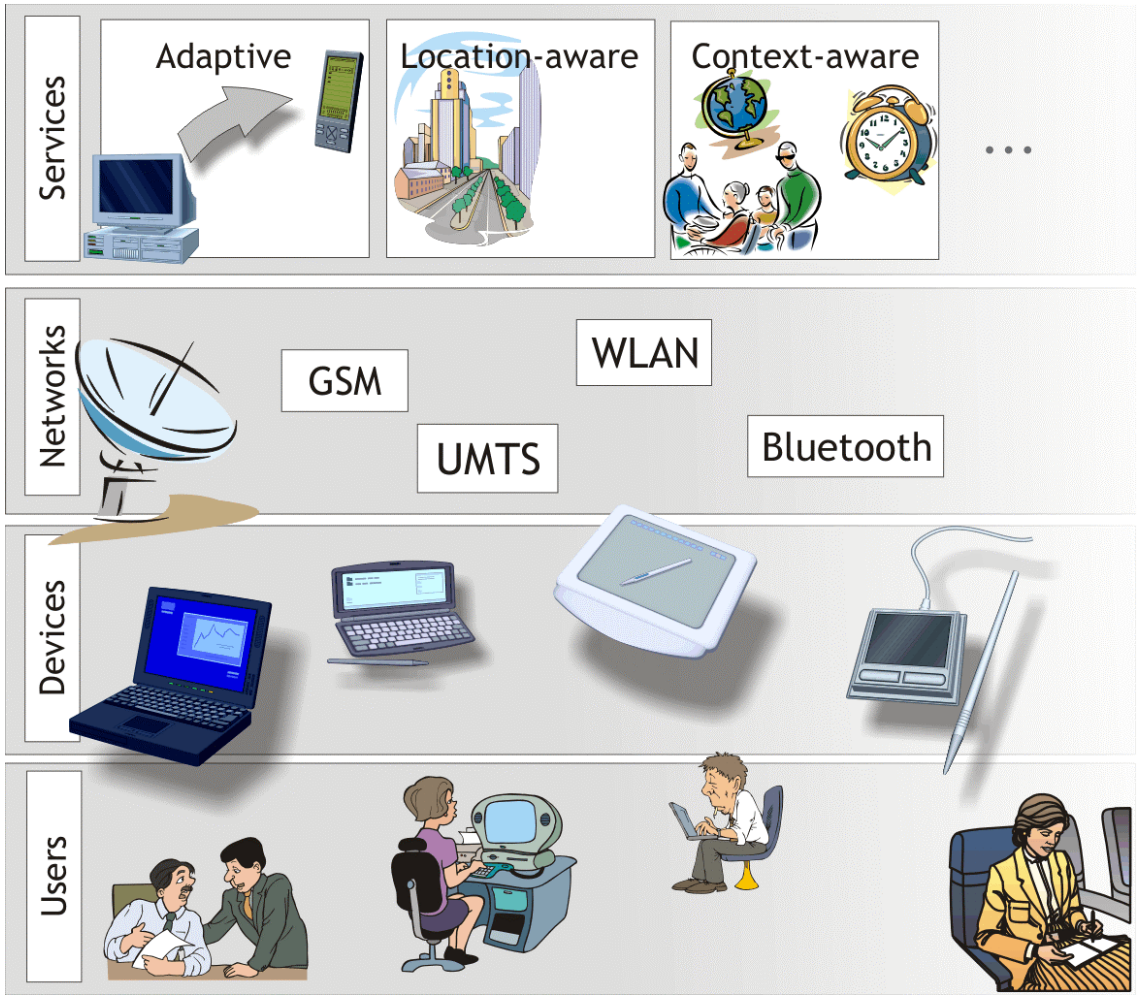
Ontologies in Wireless World

Ontologies

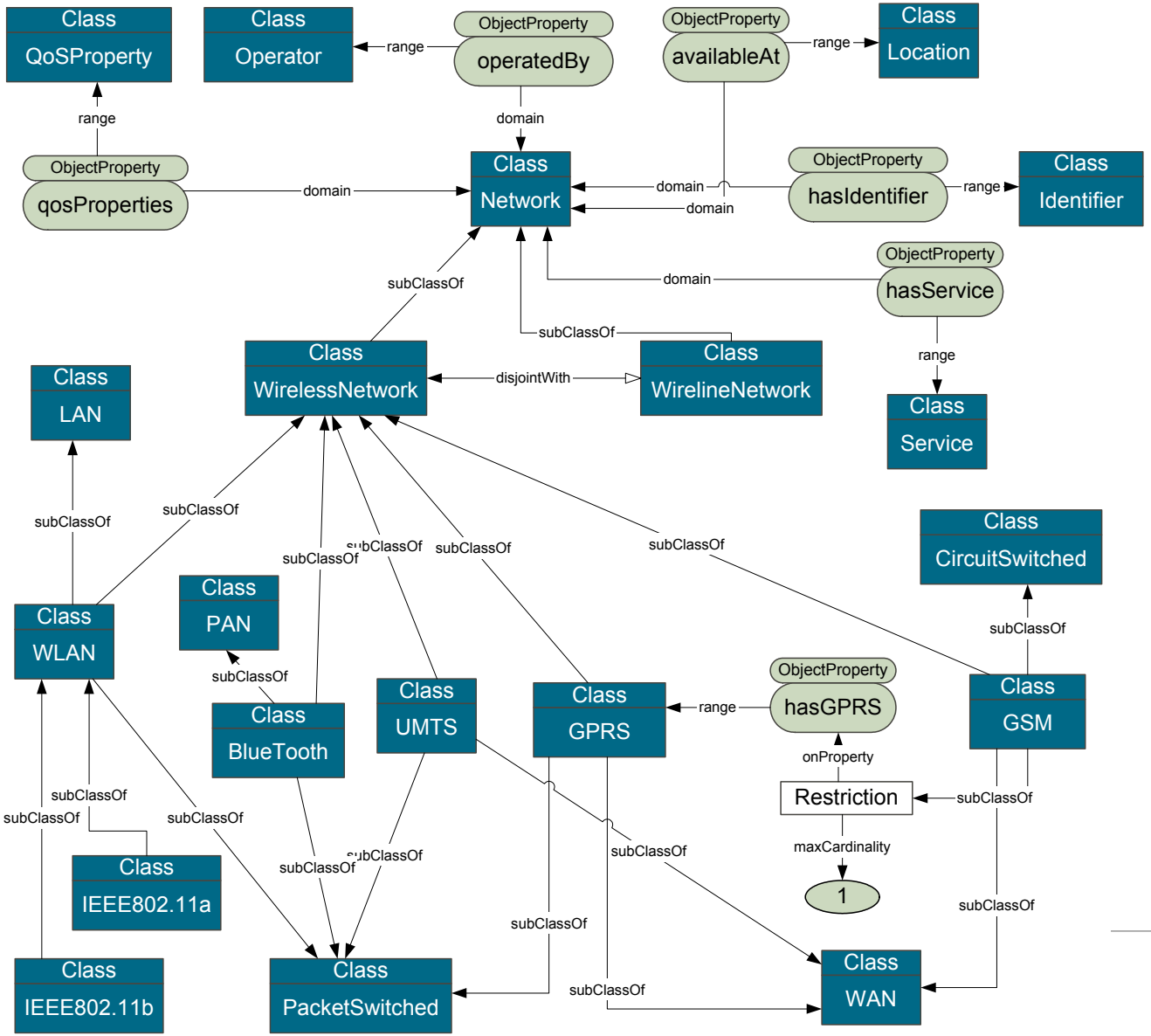
- An ontology is an explicit description of a domain:
  - Concepts
    - "Wireless network", "GSM", "GPRS", …
  - Properties and attributes of concepts
    - Each "Network" will have "Operator", "Location", "Properties", …
    - Every "IEEE802.11a" is a "WLAN"
  - Constraints on properties and attributes
    - The name of a network operator is a string
    - GSM network identifier consist of CountryCode and NetworkID
  - Individuals (often, but not always)

- An ontology defines
  - a common vocabulary
  - a shared understanding

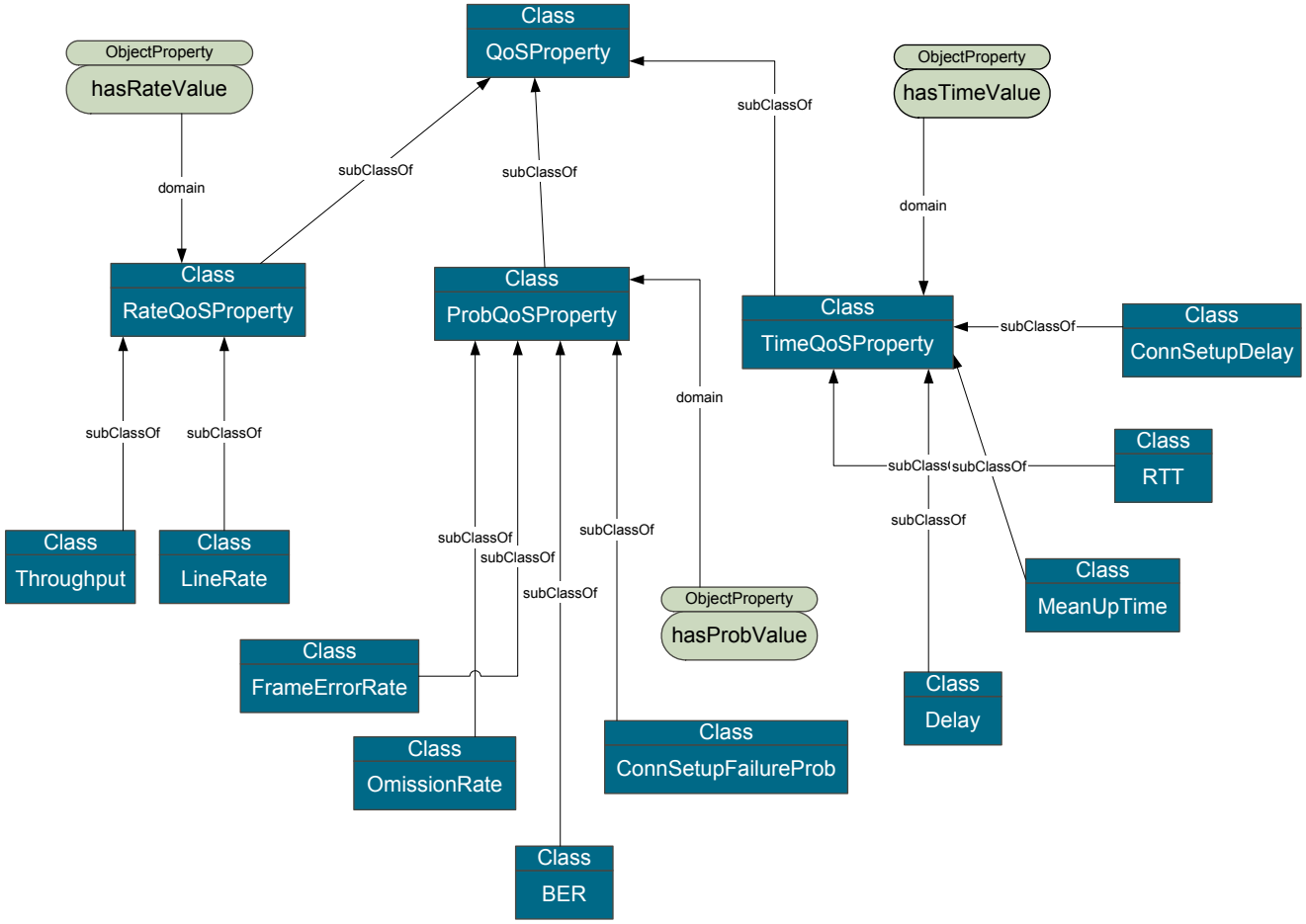
Ontologies in Wireless world



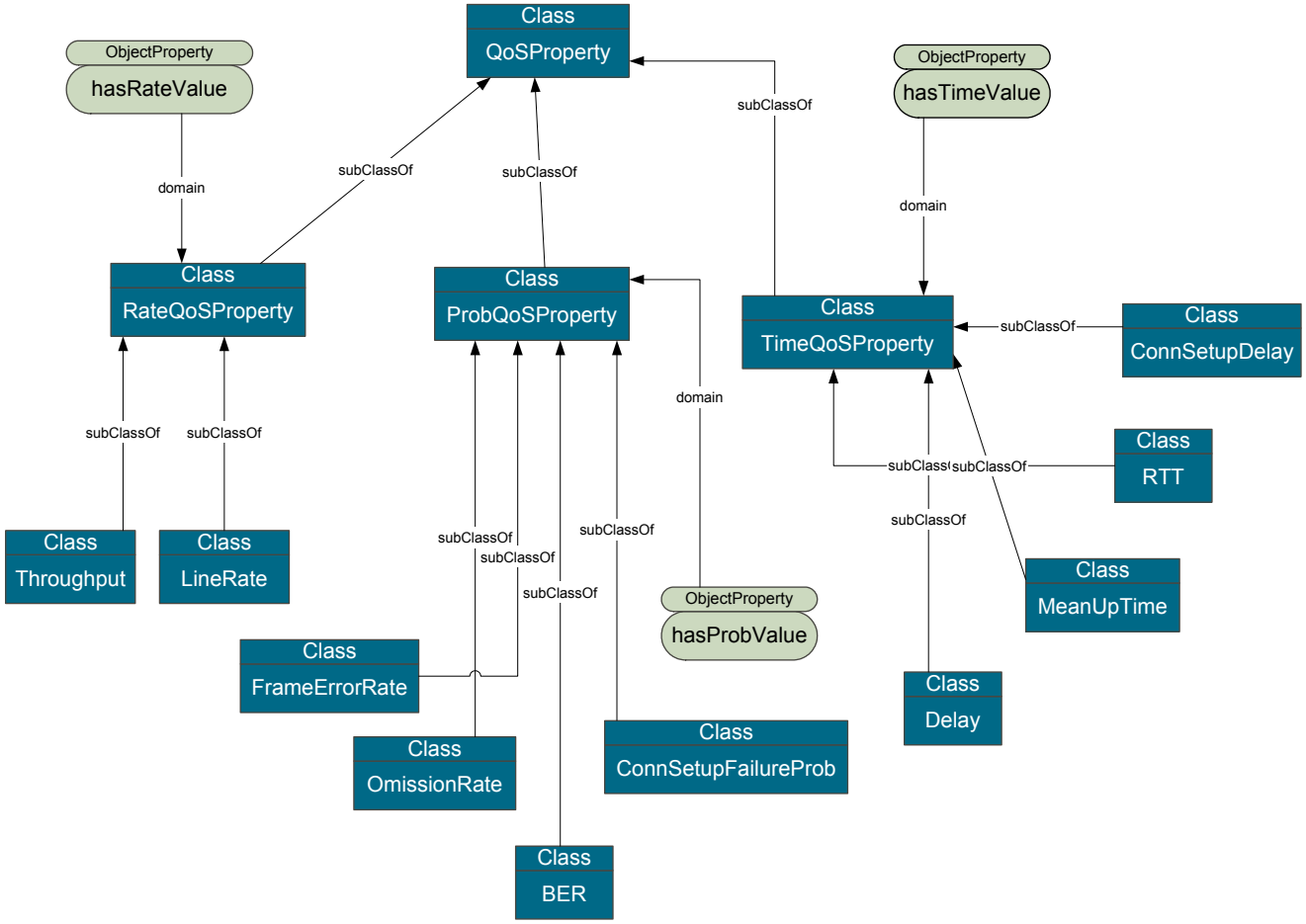
Example ontology – Wireless Networks



Example Ontology – Quality of Service



Example Ontology – Quality of Service



Example Instance

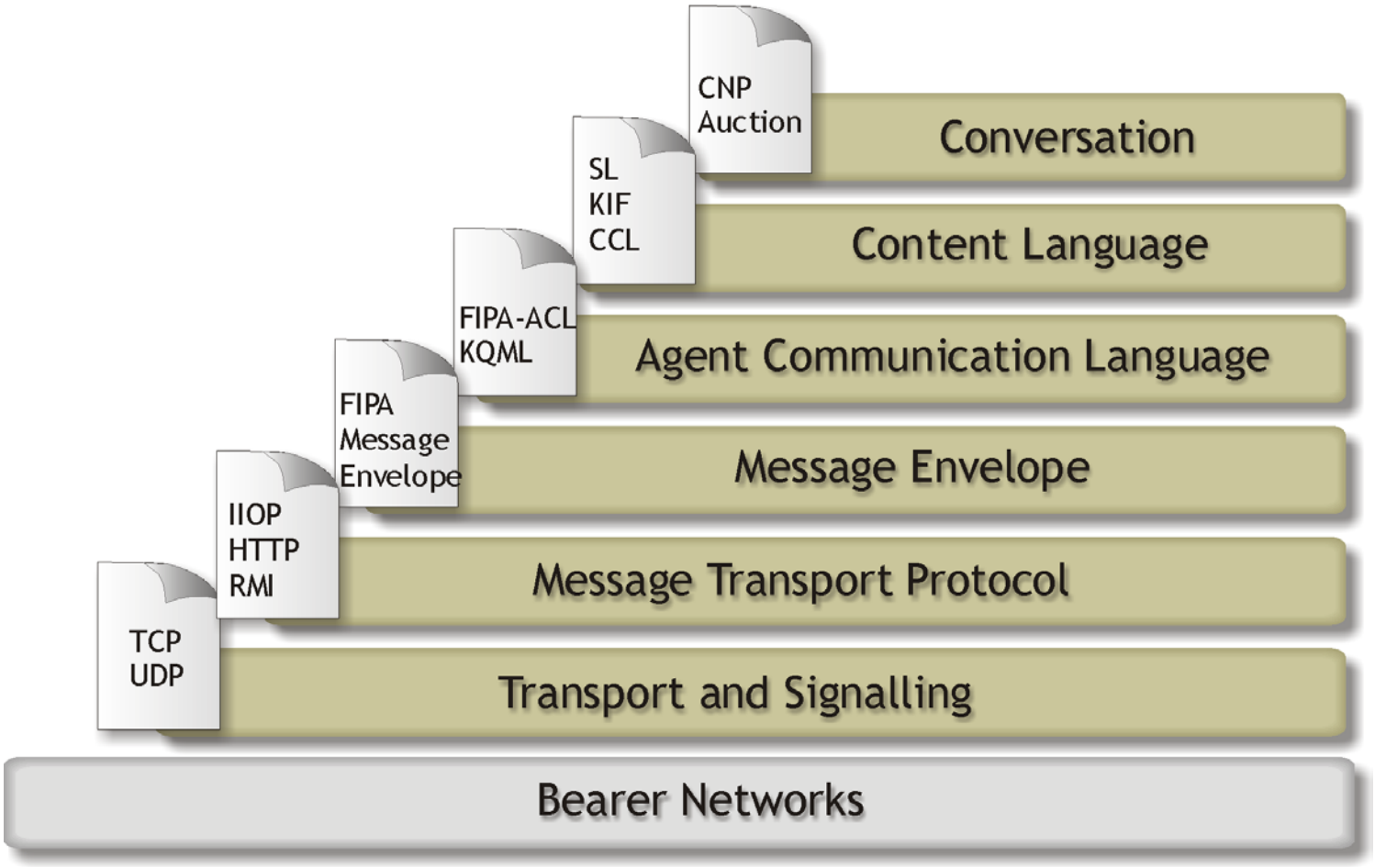
```
<daml:Class rdf:ID="GSM">
  <daml:subClassOf rdf:resource="#WirelessNetwork" />
</daml:Class>

<Operator rdf:ID="Sonera" />

<GSM rdf:ID="SoneraGSM">
  <operatedBy rdf:resource="#Sonera" />
  <qosProperties>
    <LineRate rdf:resource="#GSMLineRate" />
    <Delay />
  </qosProperties>
  <hasService> ... </hasService>
  <availableAt> ... </availableAt>
</GSM>
```

Agent Communication in Wireless World

Agent Communication

- Objects use telepathic communication
  - Direct manipulation of each others knowledge base
- Agents use more "human-like" communication
  - Speech act theory
  - Agent communication languages
    - e.g., FIPA-ACL, KQML, …
  - Ontologies for knowledge sharing

Layered Model of Agent Communication



Message Transport

- How messages are transferred between agents
- Desiderata
  - Reliability
  - Efficiency
  - Dynamic adaptation
- Issues
  - Performance problems
  - Terminal mobility
  - Thin clients

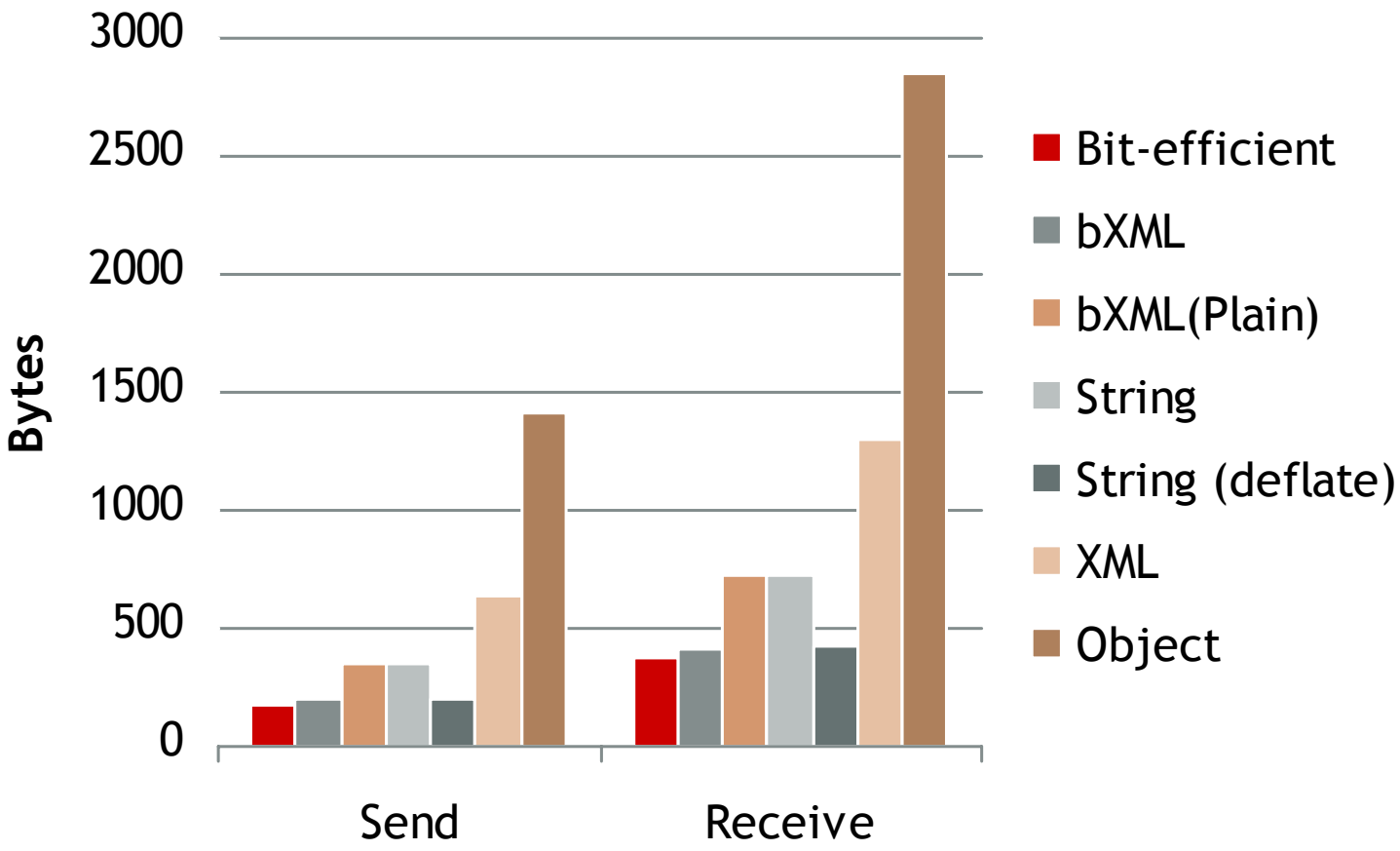
Message Envelope

- FIPA ”specific” layer
- Defines how messages are delivered
  - independent of message transport protocols
- Different encoding options
  - XML, Bit-efficient, IIOP/IDL
- Bit-efficient encoding similar to bit-efficient ACL

ACL Encoding

- Options
  - String (s-expression), XML, Bit-efficient
- Space-efficient
  - ...by definition
- Time-efficient
  - much faster
    - nice for every application; not only for wireless
    - necessity for
      - high performance applications
      - highly utilized servers
  - simple parser $\rightarrow$ appropriate for thin clients

ACL Encoding (request conversation)



Content Languages

- FIPA-SL
  - All-purpose content language
  - S-expression (w/ deflate), XML, Binary-XML (w/ special tokens)
- FIPA-CCL
  - Language for constraint satisfaction problems
  - XML & Binary-XML

- Results similar to those of message envelope and ACL

Conversation Layer

- Optimizing/modifying existing conversation protocols?
- Developing new conversation protocols?
- Selecting conversation protocol based on current environment
  - low bandwidth → simple protocol
    → not so good end result
  - more bandwidth → more complicated protocol
    → better end result

Possible Applications

- Wireless Web Browsing
  - Intelligent adaptation to changing communication environments
  - Basis for many applications
- Location-aware applications
  - Seamless roaming between different network technologies
  - Many other possibilities
- Mobile Auction scenario
  - (Intelligent) management of bid timeouts

Conclusions

- Middleware architecture
  - Several applications implemented on top of that
  - Extensions by 3rd parties
  - Standardized by FIPA (informative)
- Wireless Network/QoS Ontology
  - Minimal, but usable
  - Standardized by FIPA
- Efficient communication
  - Optimizations/tailoring needed at all layers
  - Not only works, but
    - Mostly standardized by FIPA
    - Implemented by major FIPA platforms

Thank you

Questions?