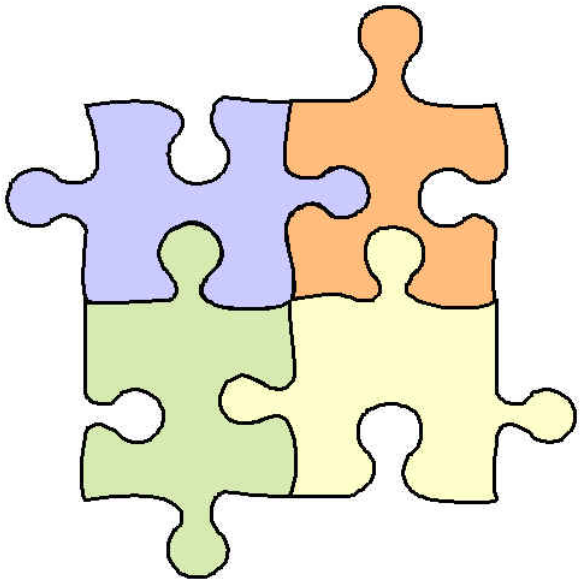
Delivering Services:
How It Can Finally Happen



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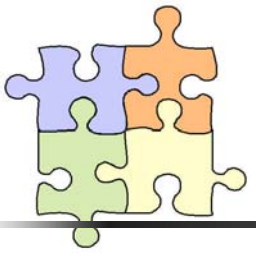
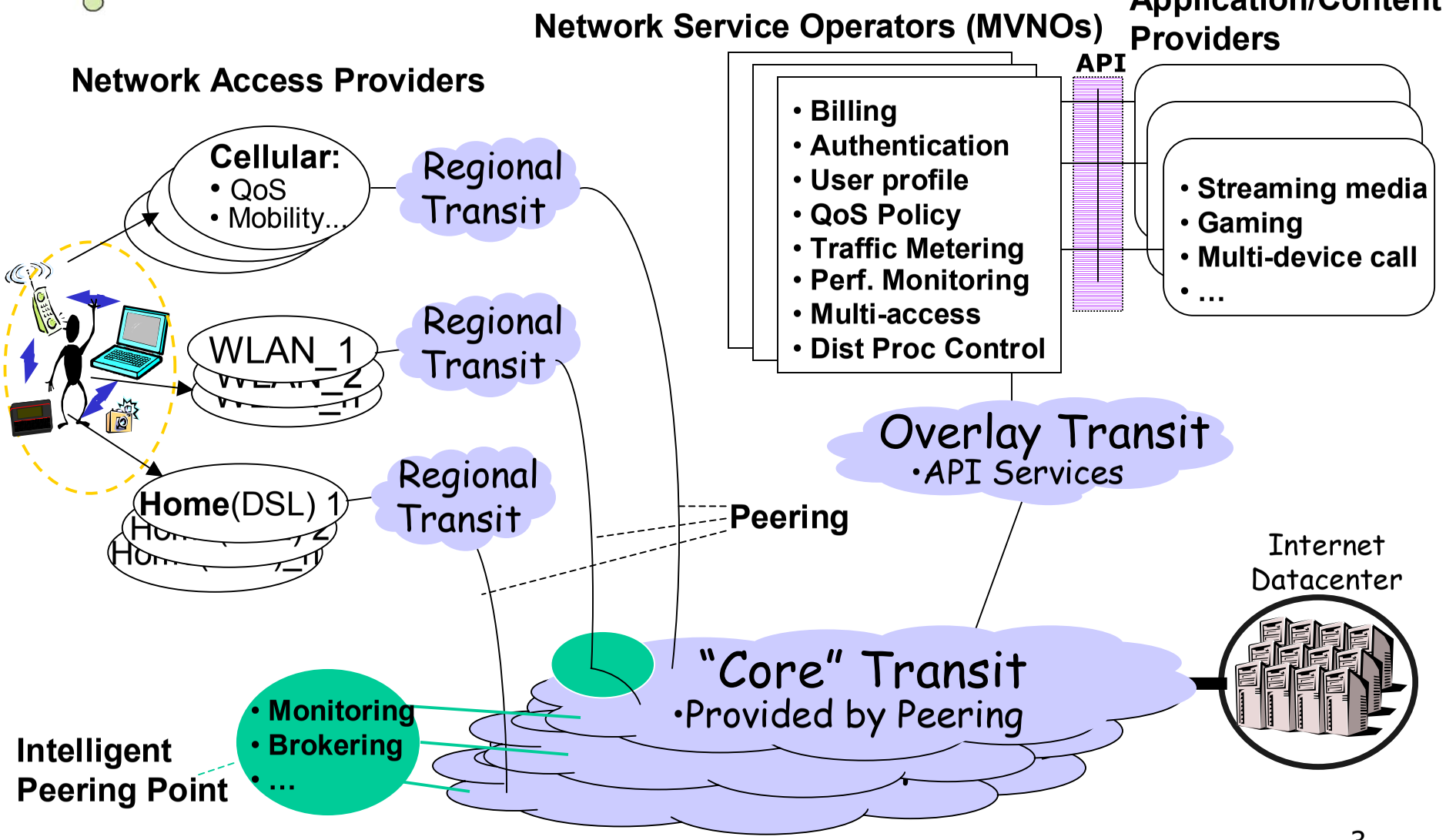


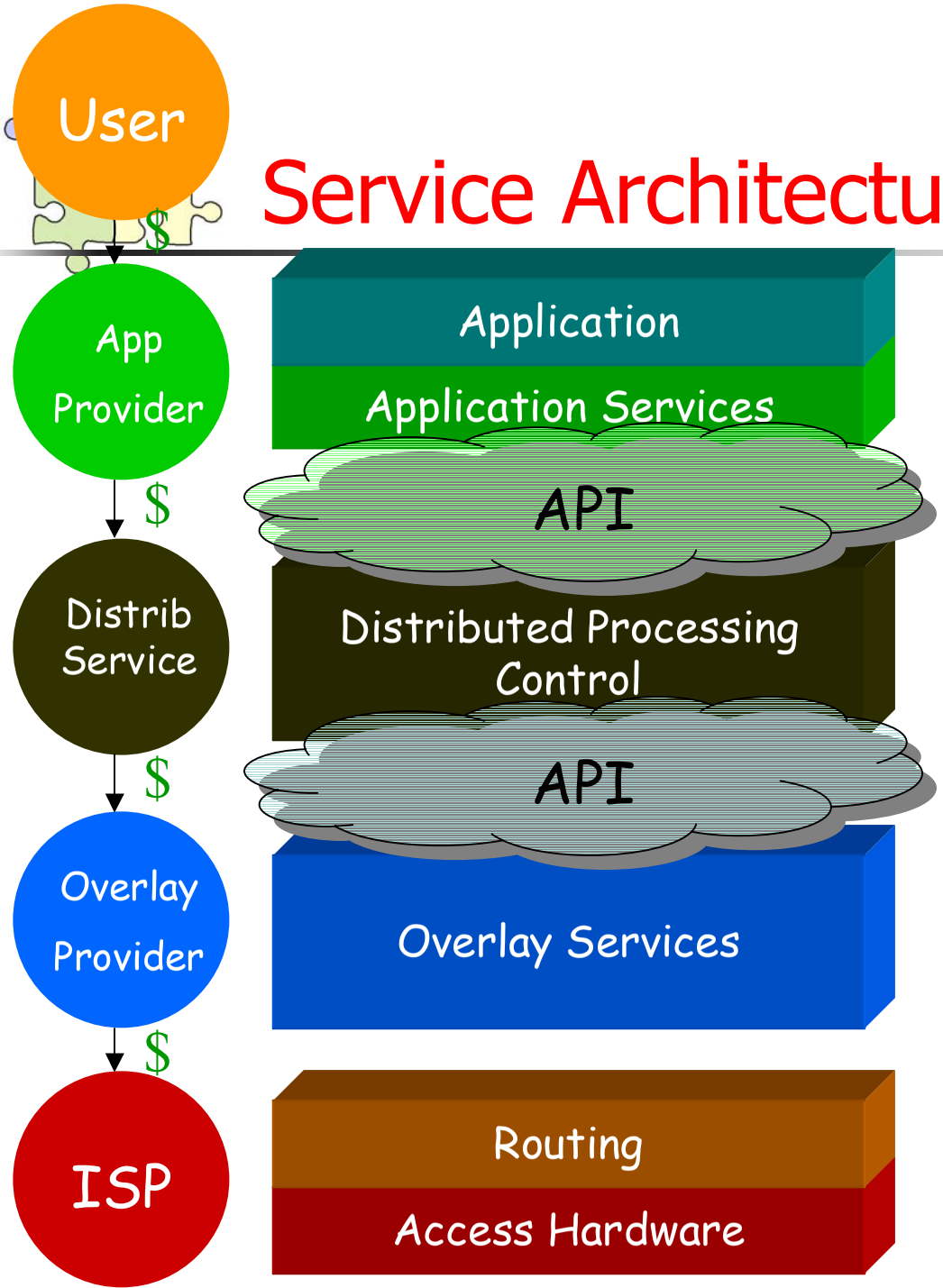
Outline

- Overview
- Application Services Layer - ASL
- Distributed Processing Control Layer
- Overlay Layer
- “Traditional” IP Layer
- Where are we today? Tomorrow?

Network/Business Architecture



Service Architecture



- Authentication
- Preferences

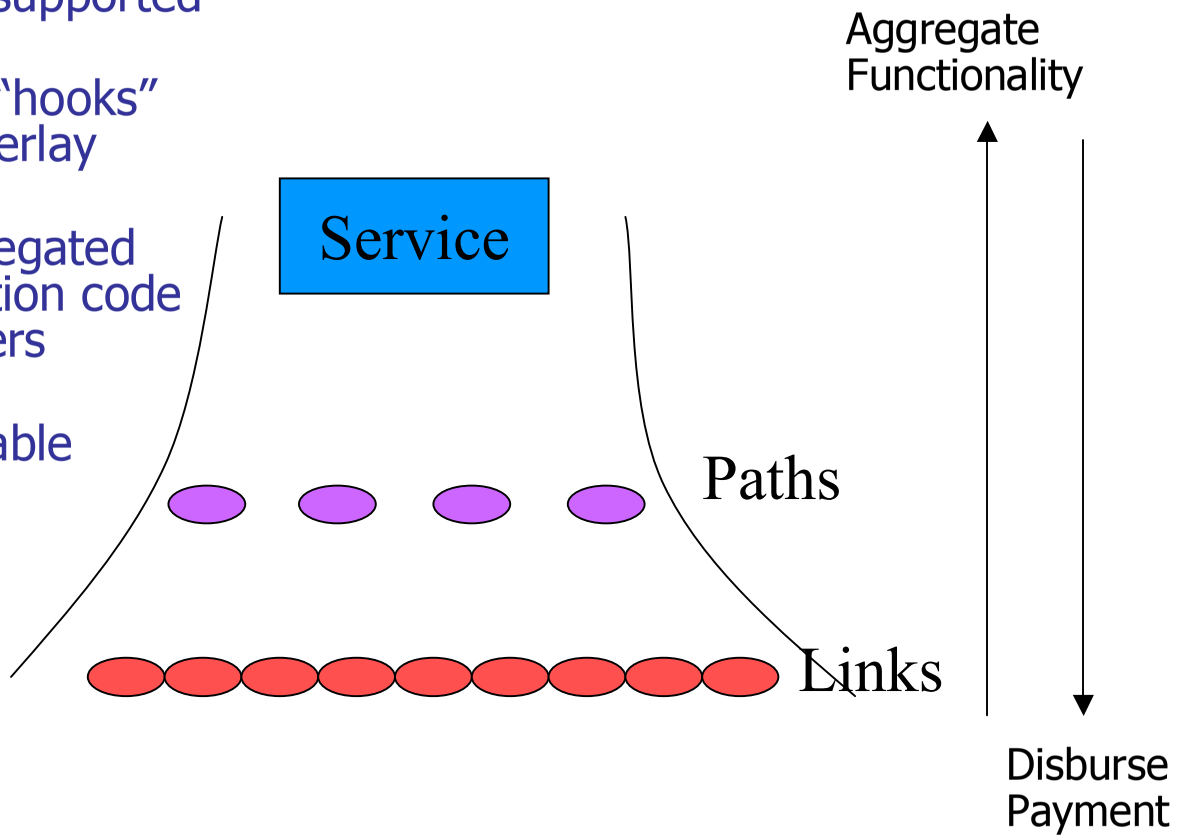
- Brokering
- Placement
- Redirection
- Connectivity
- Processing
- Storage
- Selection
- Sessions

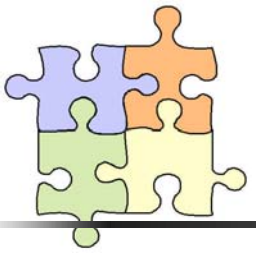
- Resource Aggregation
- Measurement/monitoring

- End-to-end connectivity

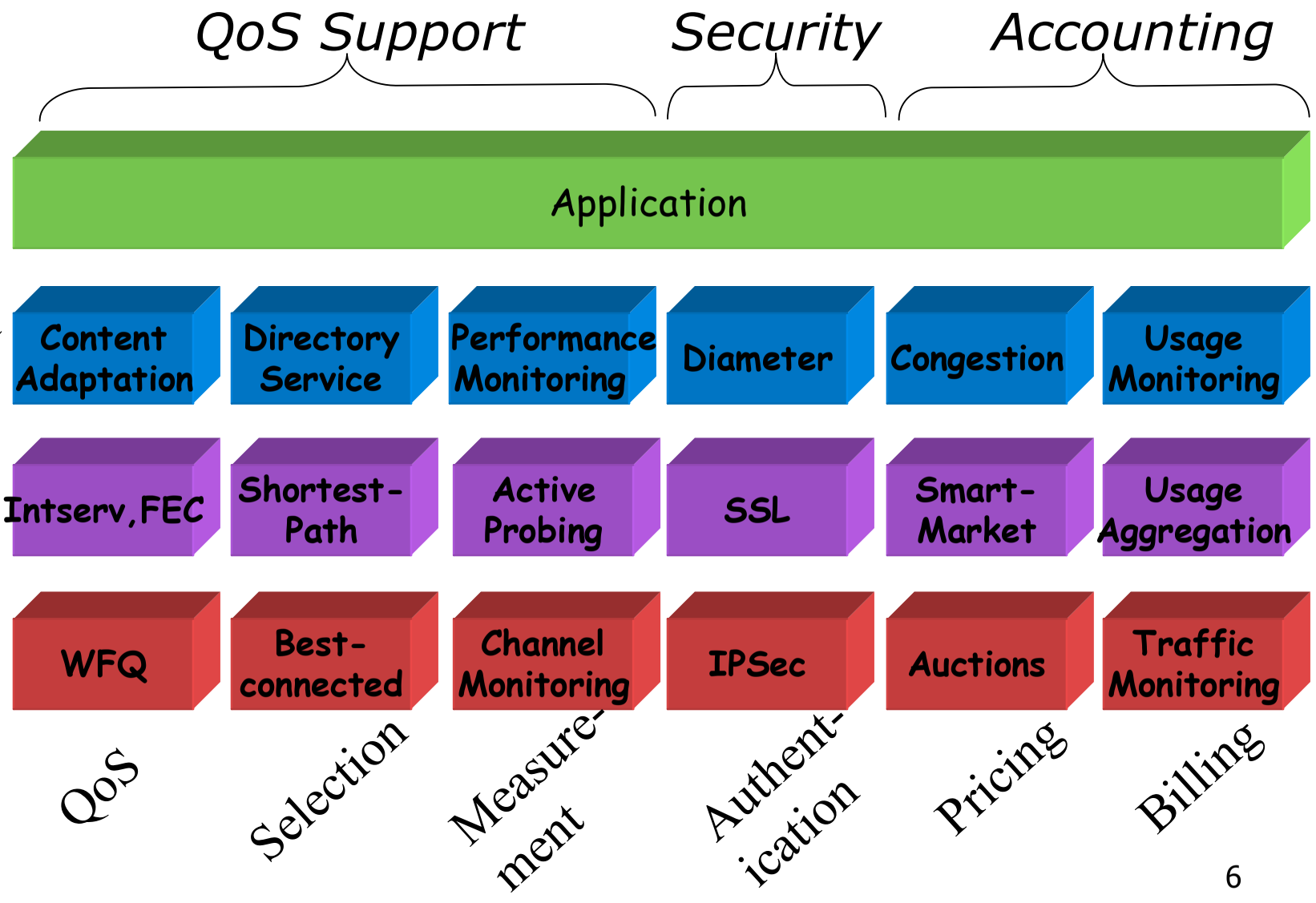
API Characteristics

- *Expressive*: functionality supported on multiple levels
- *Simple*: Implemented as "hooks" (callback functions) at overlay nodes
- *Scalable*: Interfaces aggregated for higher layers, application code multicasted to lower layers
- Supports highly dynamic mobility, highly time variable resources, and varied allocation of capacity
- Three levels
  - Service
  - Path
  - Link





API Architecture

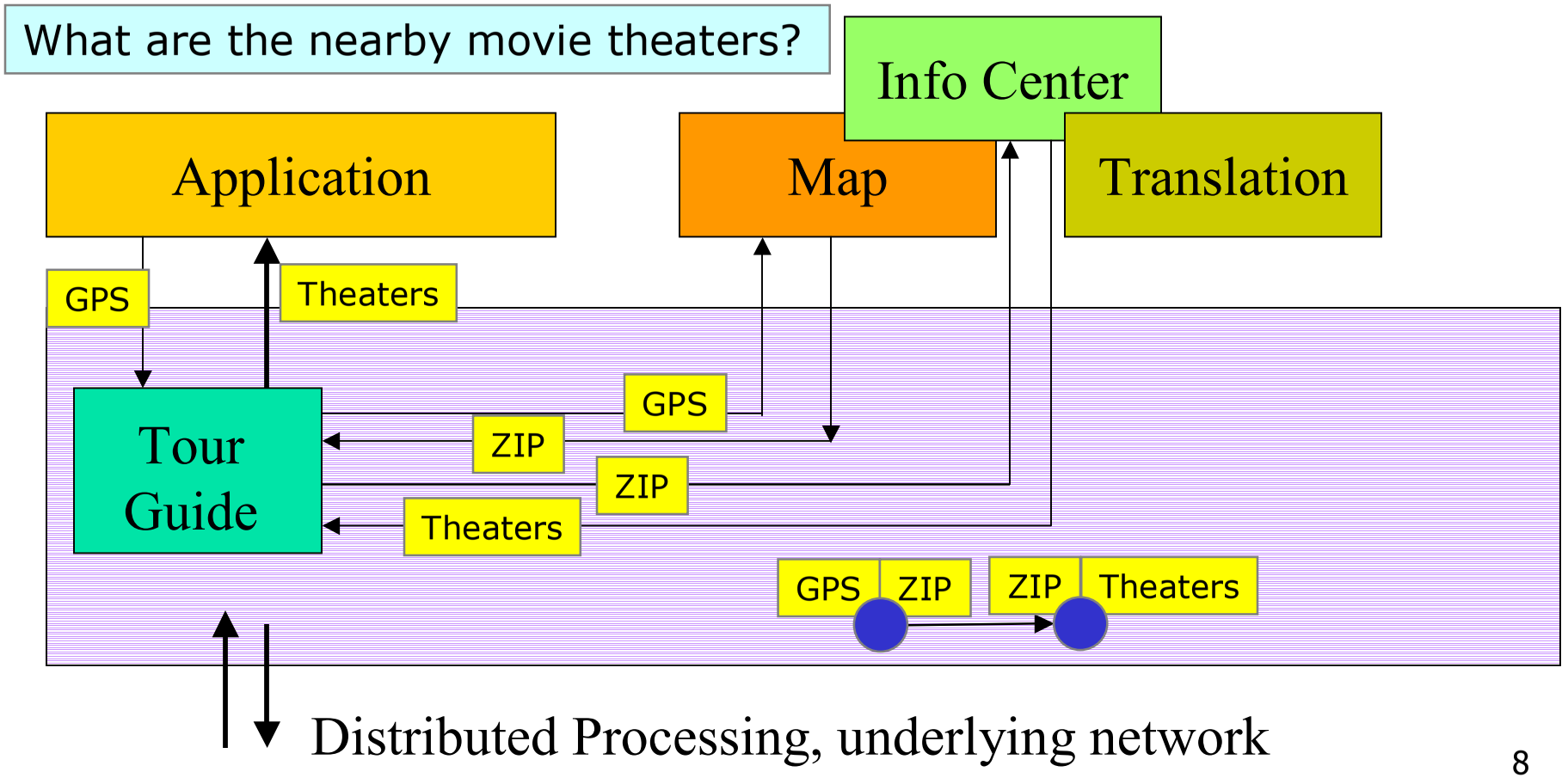


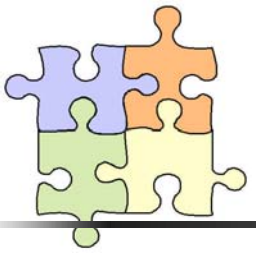
Services Composition

- Operators represent abstract operations performed by services, rather than actual entities.
- Underlying layers perform functions to support these services and how the application layer may want to combine them

Services Composition – ASL

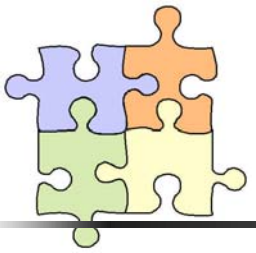
- Provides coherent, available, and customized services which the application can use



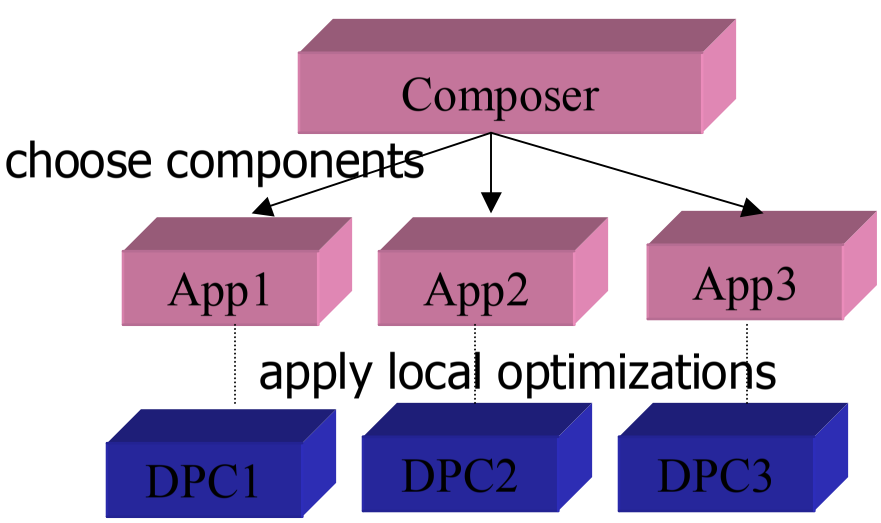


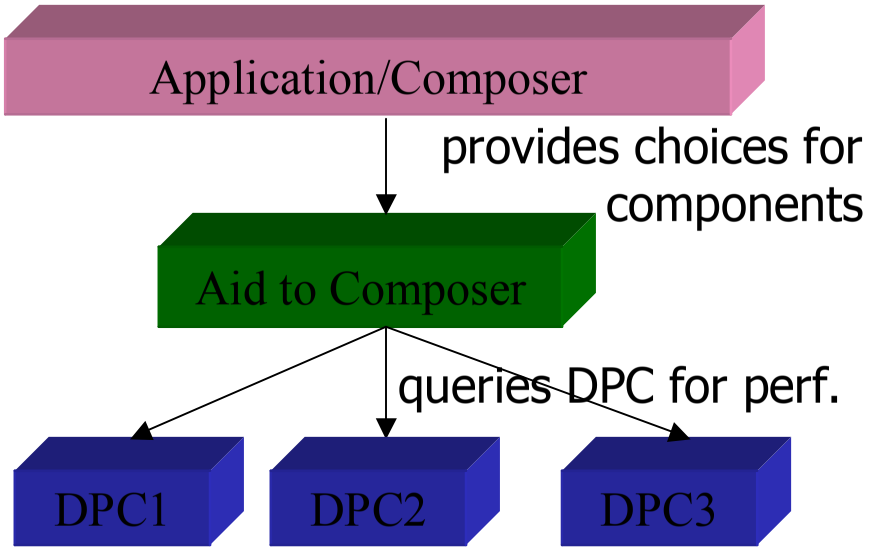
Distributed Processing Layer

- DPC-App. API needs to optimize service of specified endhosts
- The API also needs to optimize on component services (and the overlays) that they run on
- Optimization involves
  - which service runs on which overlay
  - the order of component services
  - cost constraints
  - Which services can/cannot be used



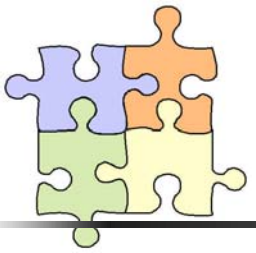
The role of DPC in the Composition?





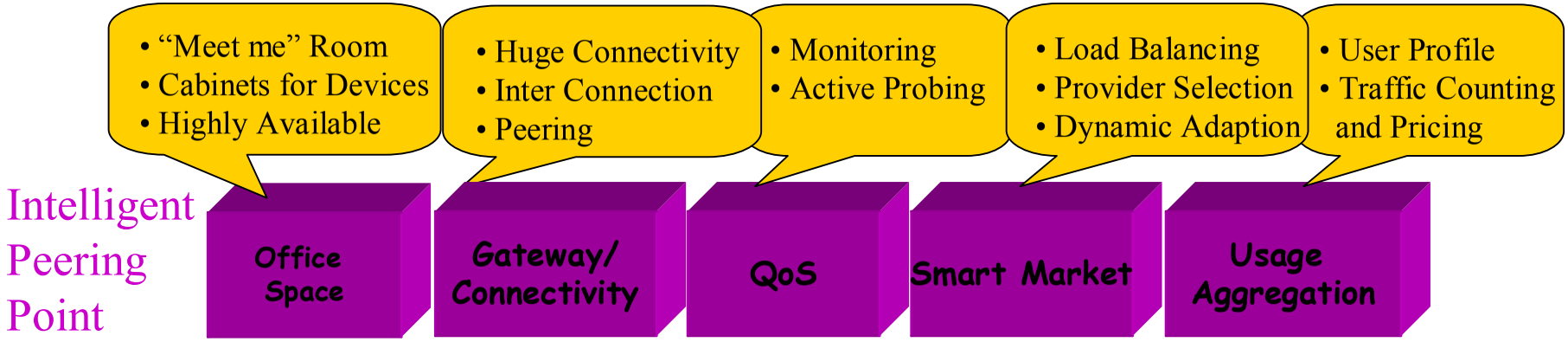
Overlay Plane

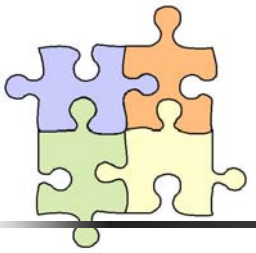
- Aggregator/Broadcaster
  - Packet forwarding/multicast, Measurement aggregation, Disbursement of Content/commands/payment to member nodes
- Filter
  - Shaping of traffic to fit constraints, Pushback to improve utilization, filter unauthorized traffic
- Source
  - Ingress Nodes: Signaling for call setup,Encapsulation/Framing of packets, Packet marking (for QoS)
- Sink
  - Egress Nodes: Decapsulation, Passive measurement of e2e service for SLA
- Selector
  - Path selection and Element Selection: with performance, load, trust, price constraints
- Coordinator
  - Interface to broker
  - Acts as peering point for SLA Management, Provisioning, Charging
  - Performs Service/path setup for application



IP Plane – Intelligent Peering Point

- Provides network on which overlay is built
  - Inter Connection: points of presence between different kinds of networks.
  - Peering: points of presence between same kind of networks with different providers.
  - QOS & Smart Market.
  - Usage Aggregation & Billing.





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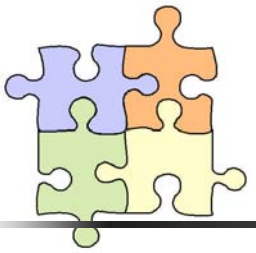
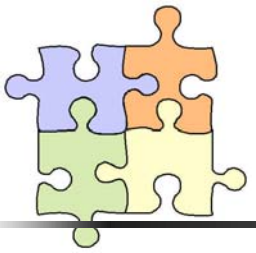


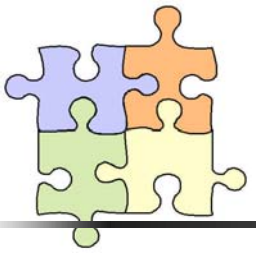
Functionality at ASL

- Service Composition (pipelining underlying services, such as text to translation)
- Lookup of the appropriate Dist. Computing layer
- Aggregation of information from lower layers into coherent format
- Masking heterogeneity (XML to HTTP, Video to sequence-of-images, French to Greek)
- Synchronication/Serialization of possibly asynchronous lower elements
- Measurement coordination/control



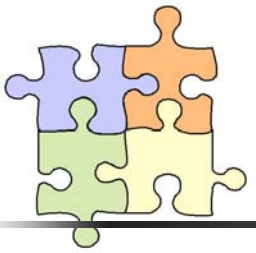
Requirements from below

- Need to parameterize services offered (uptime in percentage, bandwidth in Kb/s, storage in gigabytes, service-specific information for translation, mapping, etc)
- Need to express what we want from below
  - Conceptually like SQL
  - Select * from Translate where inp_lang=En and out_lang=Fr and reserve=100_flows



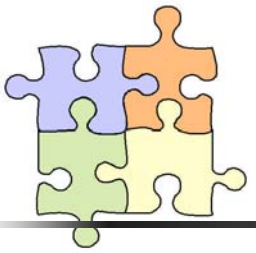
Role of message handler

- Message handler used to give lower level a way of "understanding" requirements from upper level
  - The ASL might not understand what a requirement means, and this mechanism allows the app to program the ASL with this knowledge
  - A general purpose way to add detection and enforcement for new services



Role of callback mechanism

- An application might ask for a connection with no more than 60ms latency
- The underlying network might not be able to support that anymore
- Need a way to notify the application that the underlying conditions have changed (no longer to guarantee this anymore, or perhaps can provide better service now that some flows have left the system)



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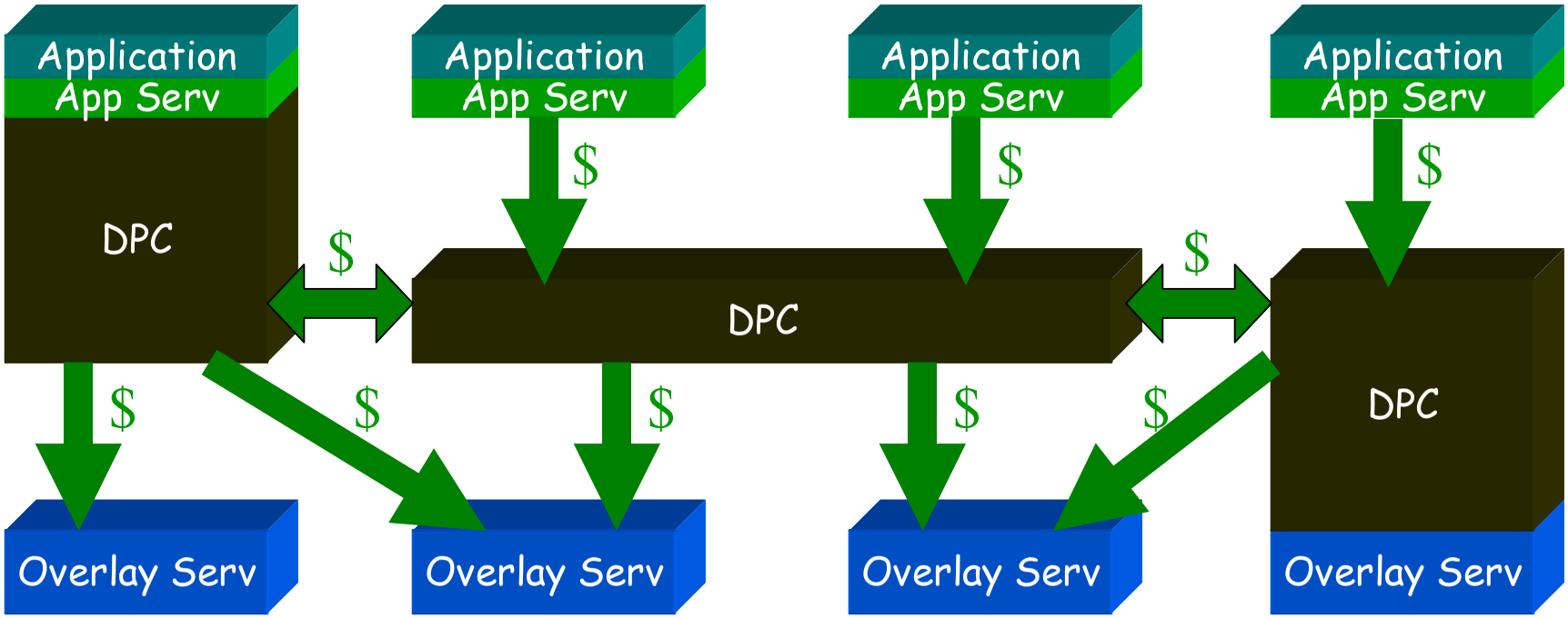
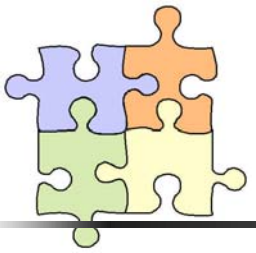
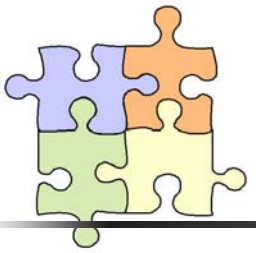
Business Model





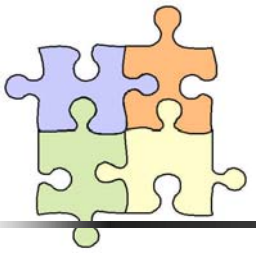
App Services <-> DPC Interaction

- Interface between DPC and App Services
  - Objects representing (virtual) endhosts and their attributes such as location, importance (e.g., number of users served), QoS desired.
  - Create virtual gamespaces and associate each endhost to one of these (independent instances of the game).
  - Specifies policy that is used in making decisions about involving overlay providers and specific resources.
- DPC Functionality
  - If gamespace consists of nodes from different overlays, a local DPC layer may act as a translator/redirector between overlays. This may involve heterogeneous overlays(processing and storage).
  - Given endhost object, select nearby server from various overlays.
  - Run introspective algorithms to assist future placement of overlay nodes.



DPC <-> Overlay Interaction

- Provides uniform interface to resources for the app.
- Aware of 3rd party, same-party and client (localhost) overlay nets.
- Gets resource availability and measurements from overlay providers.
- Using App's QoS/resource/device request, transparently selects the optimal resources, or allows app decision.
- Provisioning can be long-term, session-duration or dynamically within a session.
- Brokers connections between overlay providers.
- Manages inter-overlay communications migration when measurements indicate better resources should be chosen (different than intra-overlay migration, which is transparent to DPC layer).



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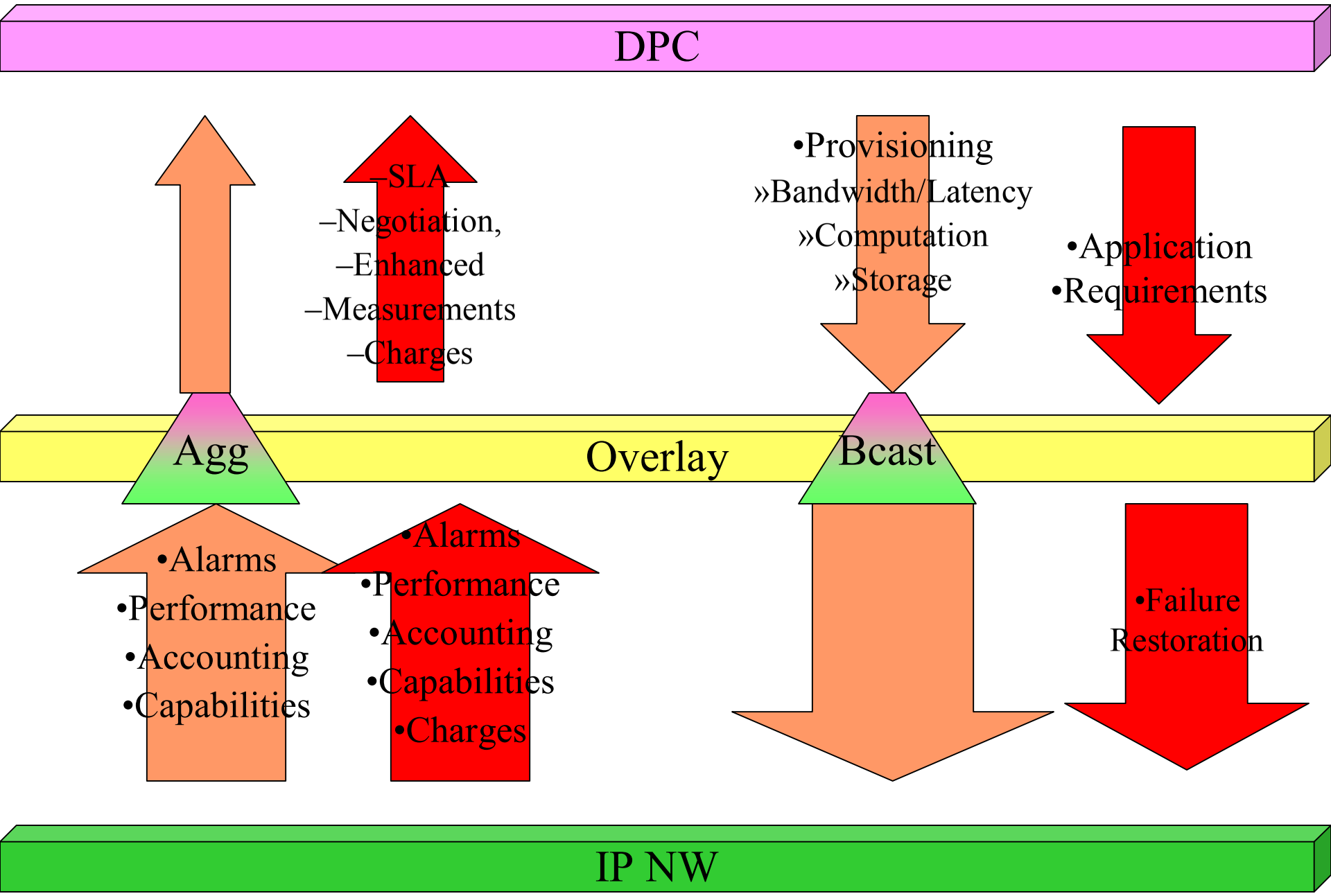
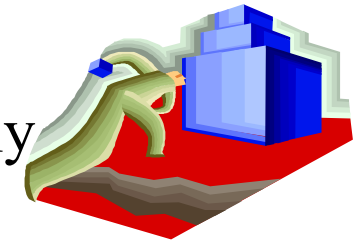
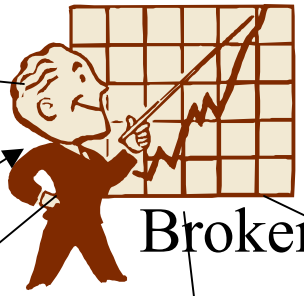
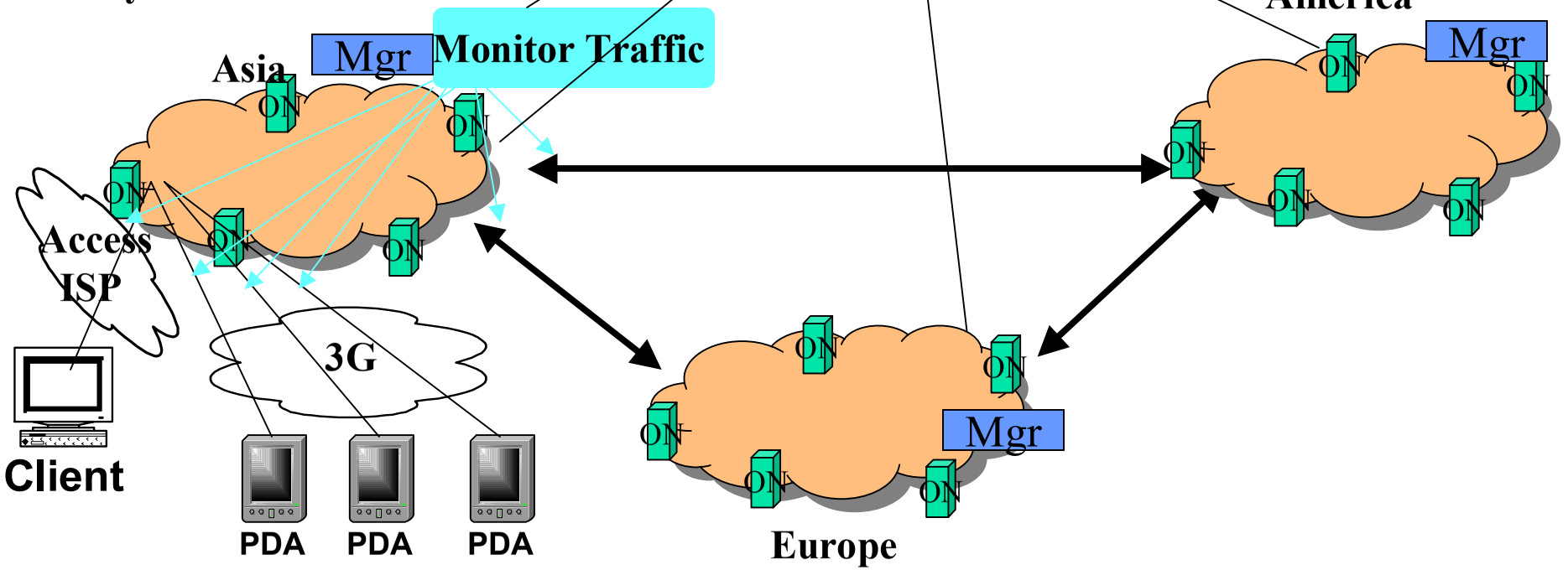

DPC
–SLA
–Negotiation,
–Enhanced
–Measurements
–Charges
•Provisioning
»Bandwidth/Latency
»Computation
»Storage
•Application
•Requirements
Agg
Overlay
Bcast
•Alarms
•Performance
•Accounting
•Capabilities
•Alarms
•Performance
•Accounting
•Capabilities
•Charges
•Failure
Restoration
IP NW

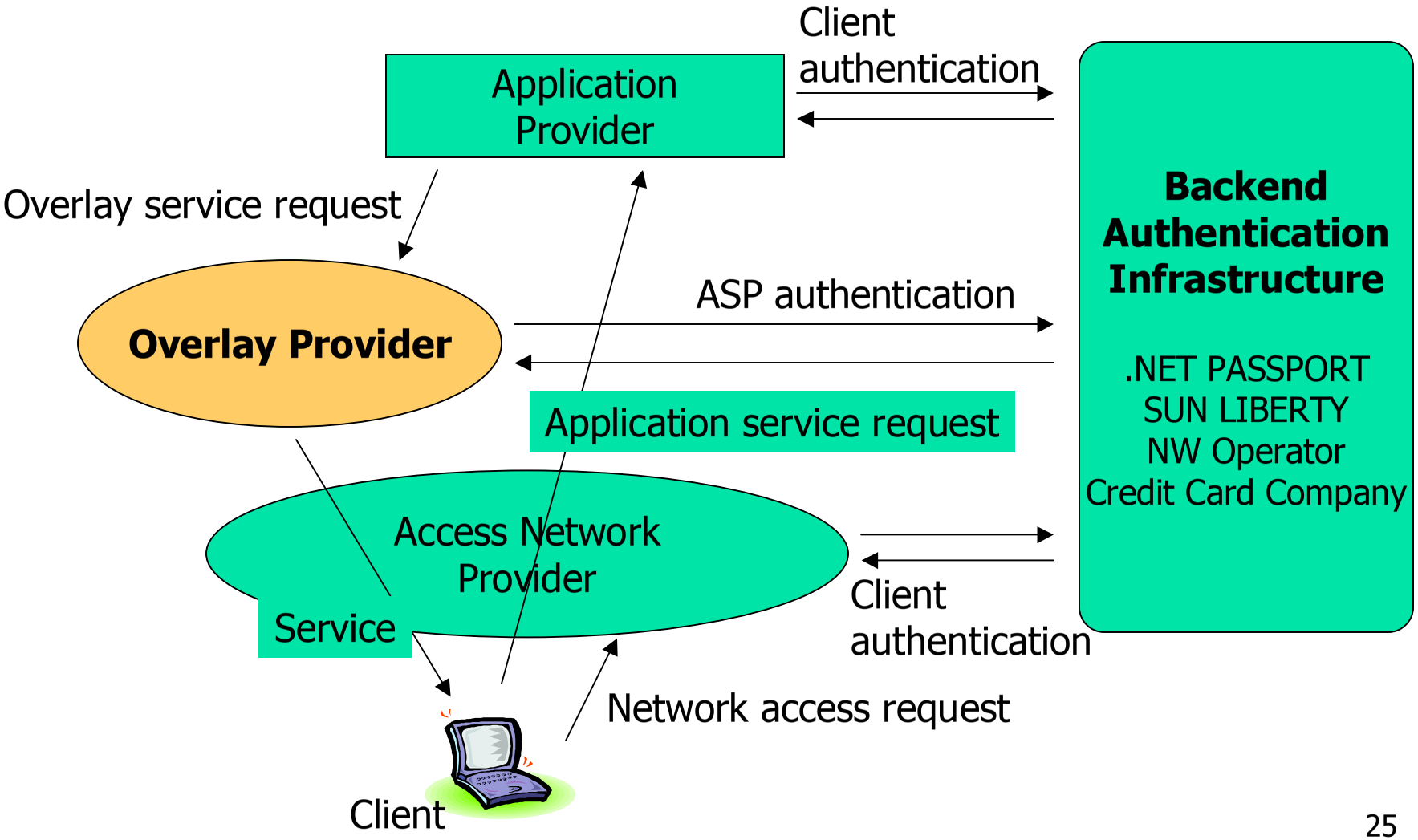
Billing between Overlay Networks



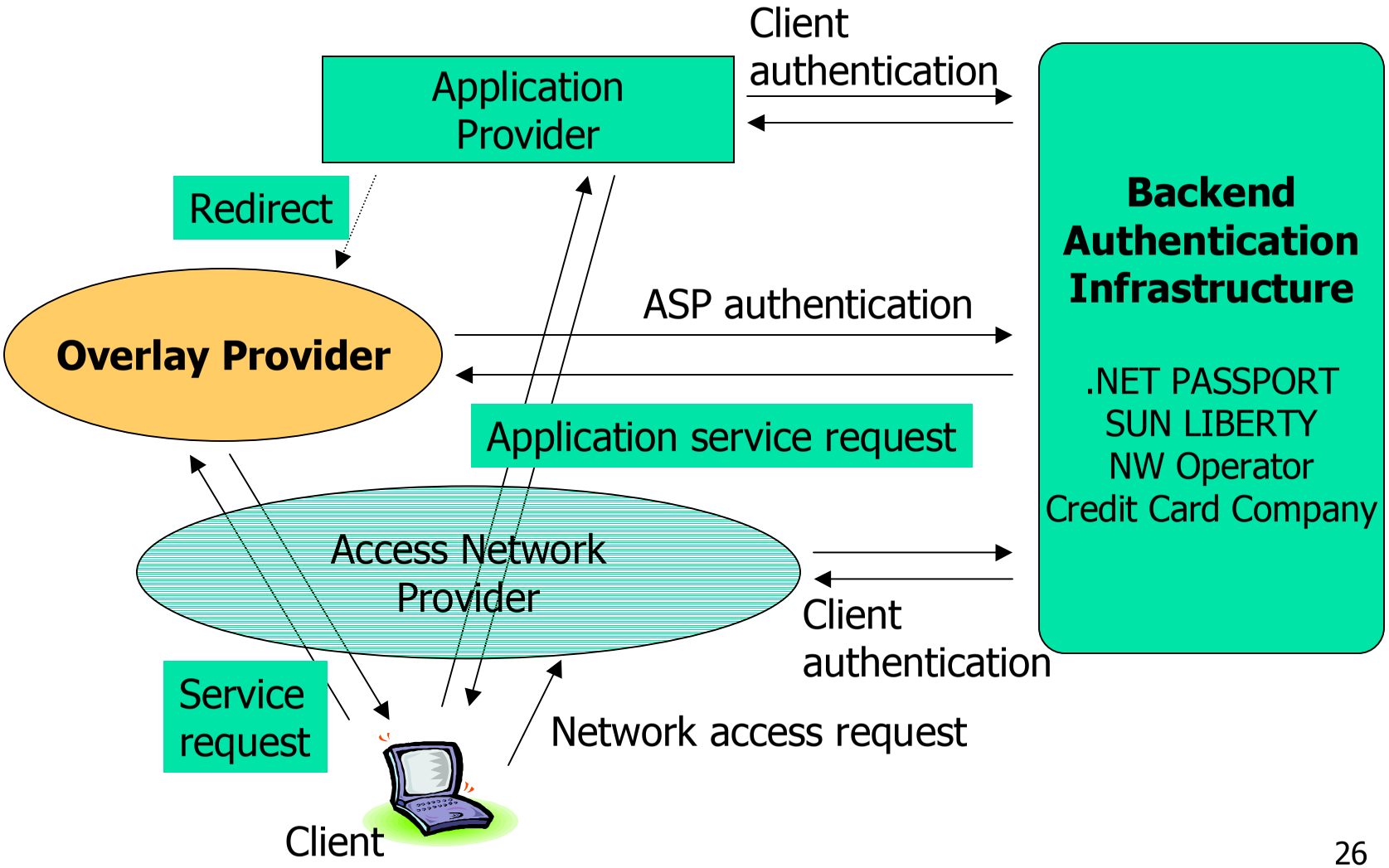


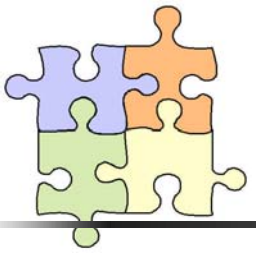


Overlay in authentication chain



Overlay in authentication chain ~request redirection

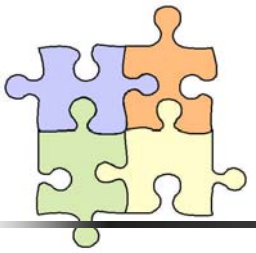




Assumption

- End user uses overlay service only through application service provider
- End user pays for application, not for overlay service
- Overlay provider gets revenue only from application provider

- Overlay provider must
  - authenticate ASP, or verify end user owns valid token issued by ASP
  - log service provided
    - Number of byte, hit, etc…



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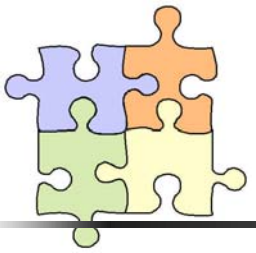
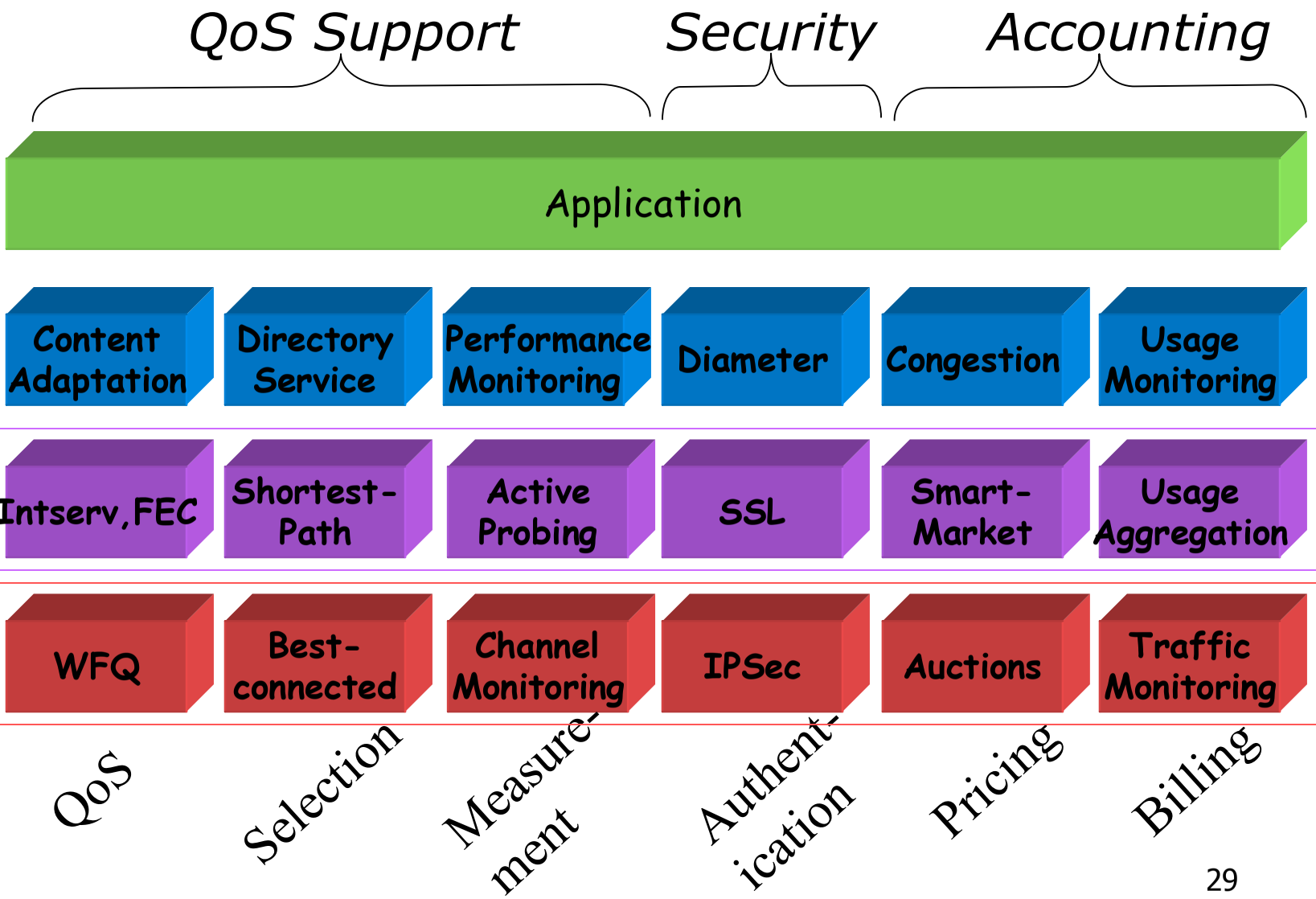
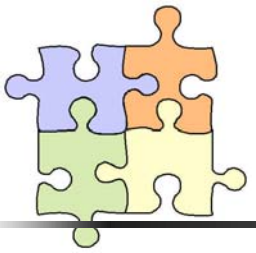


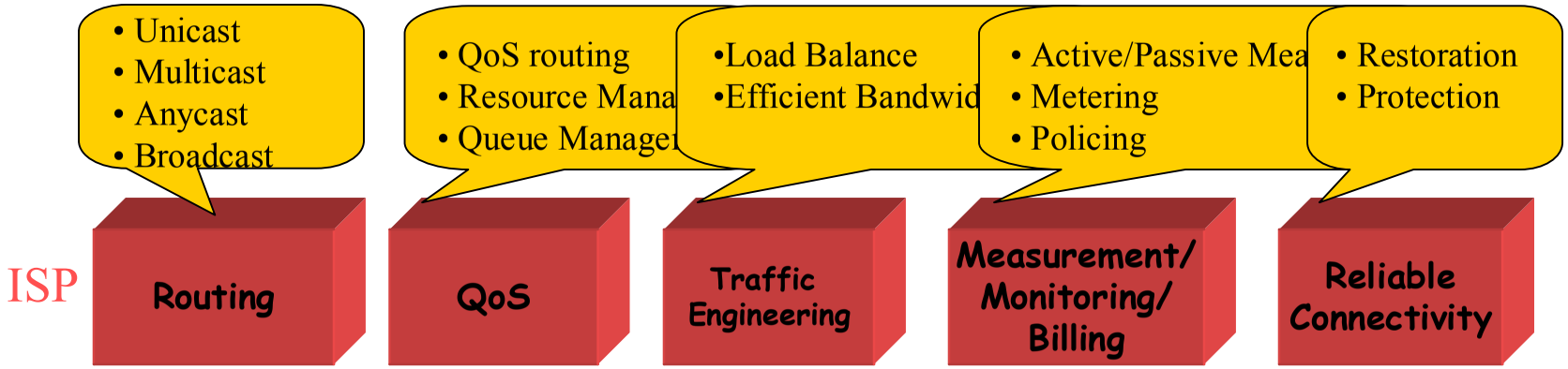
API Architecture





Functionalities Inside Transit Networks

- Provide connectivity across wide-areas
- Provide information for accounting/billing



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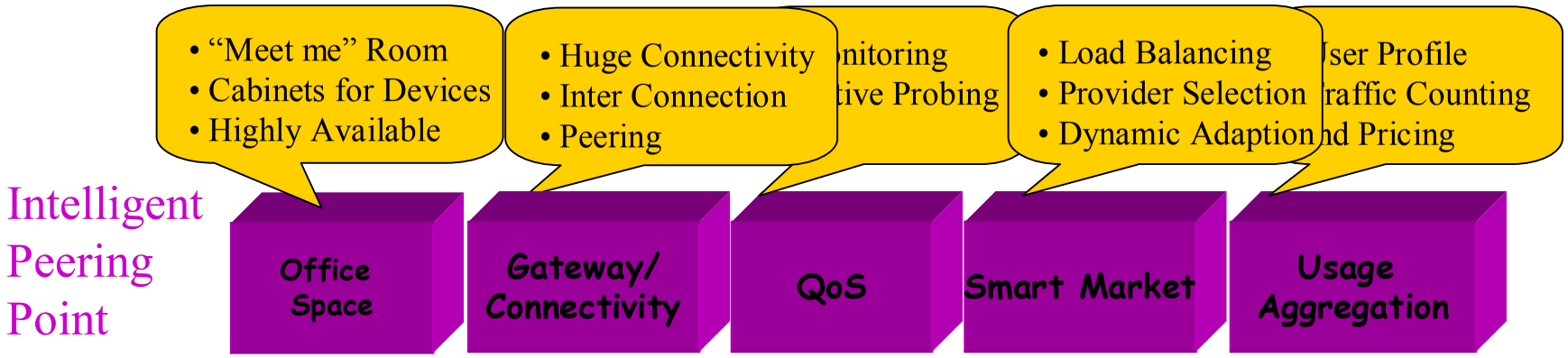

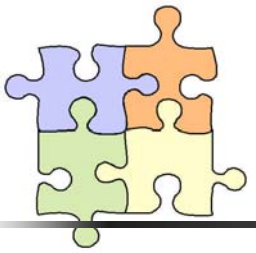

Where are we today? Tomorrow?

- MVNOs are here (See my MVNO presentation)
- What about the services?
  - Current wireless providers in the US want to keep applications closed
  - Companies with services to deliver (Microsoft, AOL) want to open things up to third party providers
  - The only way to generate the revenue to support the building of next generation networks is to create an environment where a plethora of services can flourish

More Information…

Please check out my Services, MVNO web page:
http://www.perlegos.com/services/services.htm

My research web page on Overlay Networks:
http://www.perlegos.com/research/research.htm

You can find my web page at:
http://www.perlegos.com/

If you have any more questions, e-mail me:
pete@perlegos.com