Network Slicing:

Technical Viewpoints and Functional Roles

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Context

- Current architectures/protocols...
  - ...are conceived for their specific purpose,
  - ...provide disconnected virtualization approaches,
  - ...do not provide homogeneous interfaces
    (for consumers to do CRUD on multiple elements),
  - ...do not promote inter-* compliancy
    (so migration among “providers” is difficult and costly).

- Network services need the ability to evolve...
  - ...instead of being replaced by totally different ones,
  - ...to incrementally deliver more and/or better capabilities,
  - ...to respond to dynamic incidents and requirements.

Basic Requirements (I)

- **Enlarged and Ubiquitous Infrastructure Flexibility**:
  - Both underlying and overlying network elements can be added, removed, scaled up/down, re/connected, re/configured, etc. in terms of seconds/milliseconds instead of minutes/hours.

- **Network Resource Plasticity**:
  - Flexibility is also taken to the atomic level:
    - Bound/Fixed Resources => Plastic/Elastic Resources:
  - Plastic resources change their shape dynamically and promptly in response to stimuli coming from different sources:
    - Consumer requirements:
      - Specified through a standard and simple interface,
      - Current interfaces cannot address such specifications…
    - Changes in the working environment (events),
    - Changes in the workload (traffic spikes, slashdot effect),
    - ...

Basic Requirements (II)

- **Composability:**

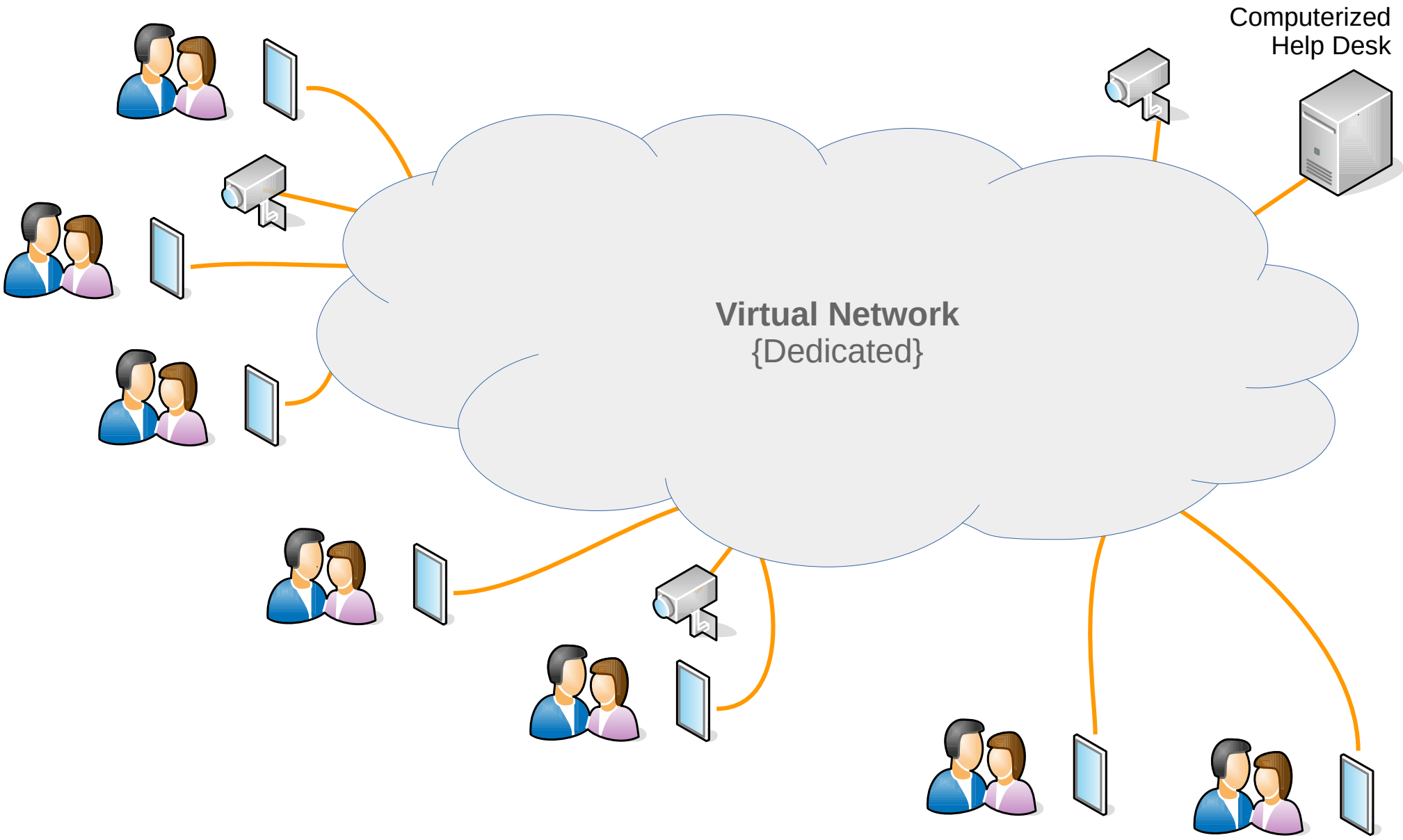
  (Composite Network Resources and Services)

  - Inherited features/capabilities/qualities from the original resources.
    - Provider independent,
    - different natures (computing, storage, security, etc.),
    - ...
  - Favoring reusability => Enhanced reliability:
    - Encourage their building and consumption.
  - Like a “crosswise SFC”.

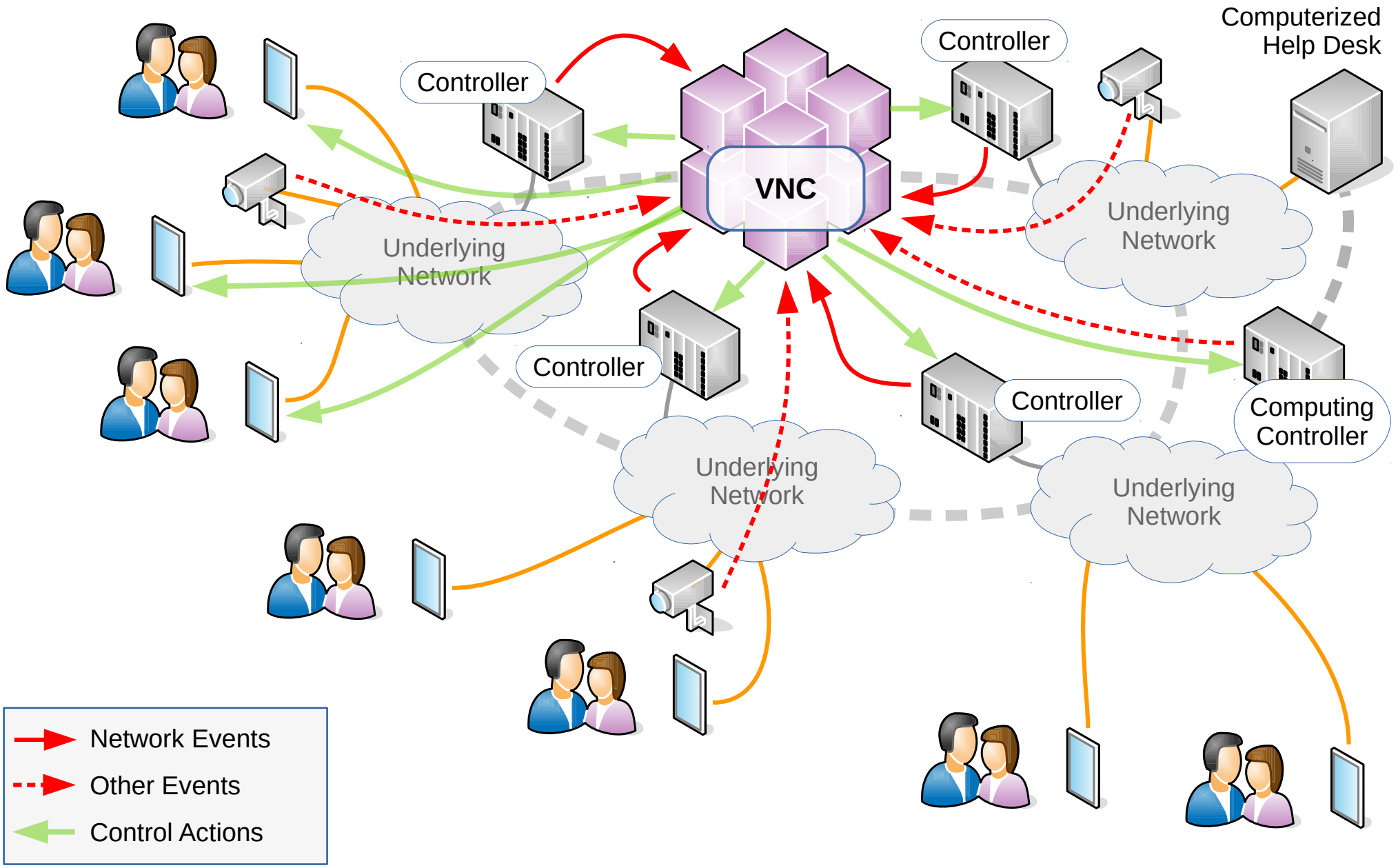
- Other*:
  - Assured isolation, scalability, reusability.

(*) http://sdn.ieee.org/newsletter/january-2017/challenges-of-network-slicing

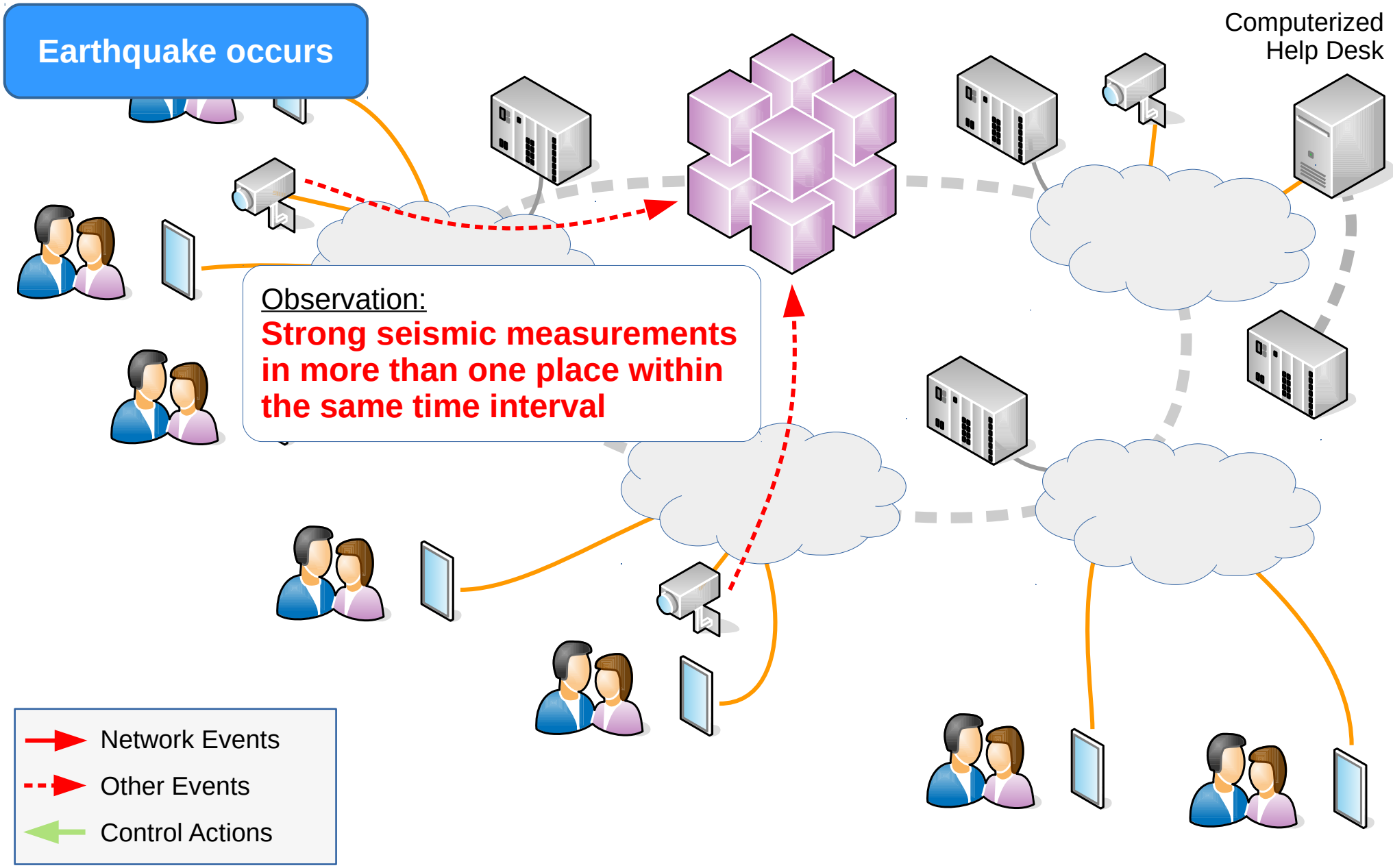
Potential Use Case (I)



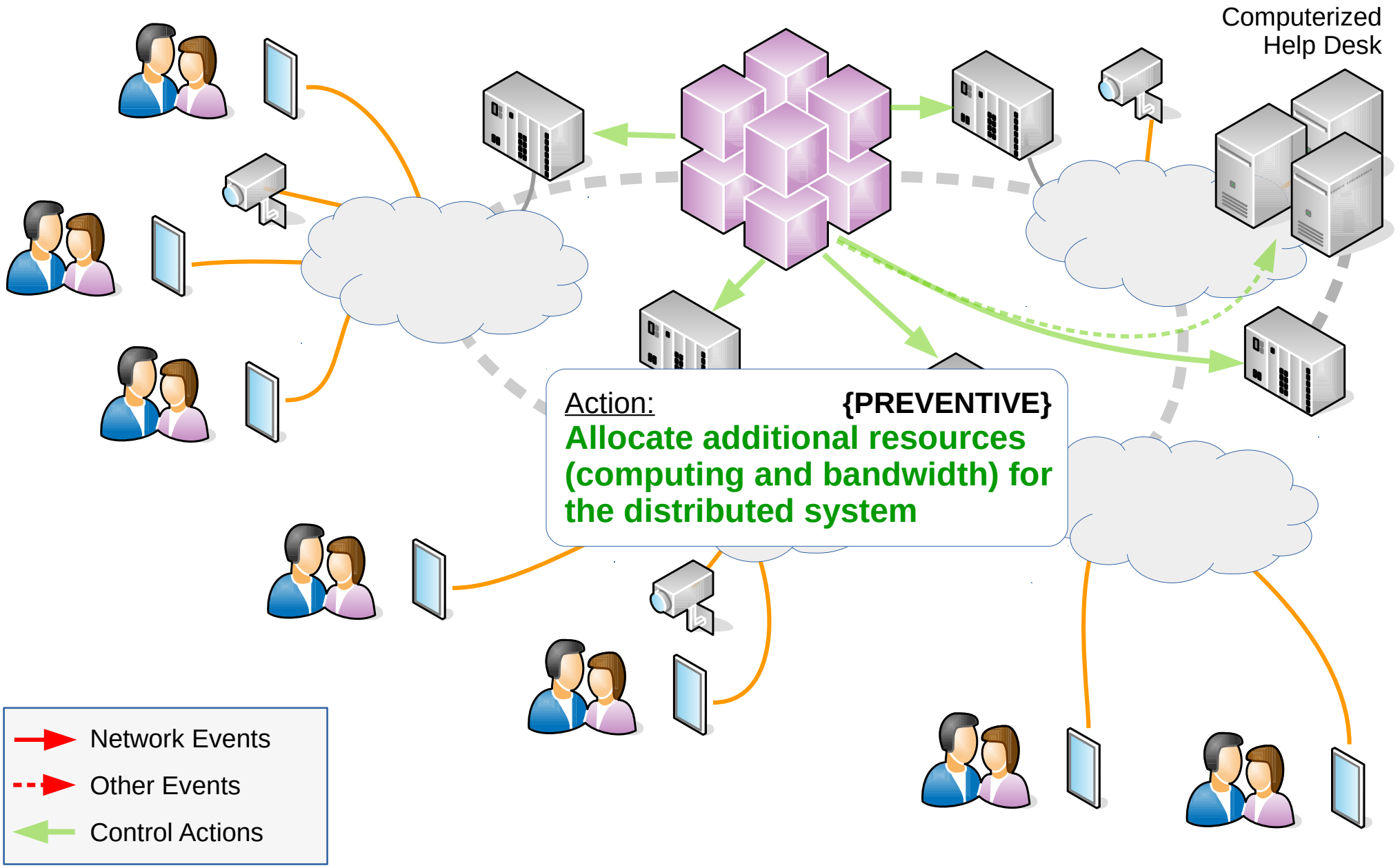
Potential Use Case (II)



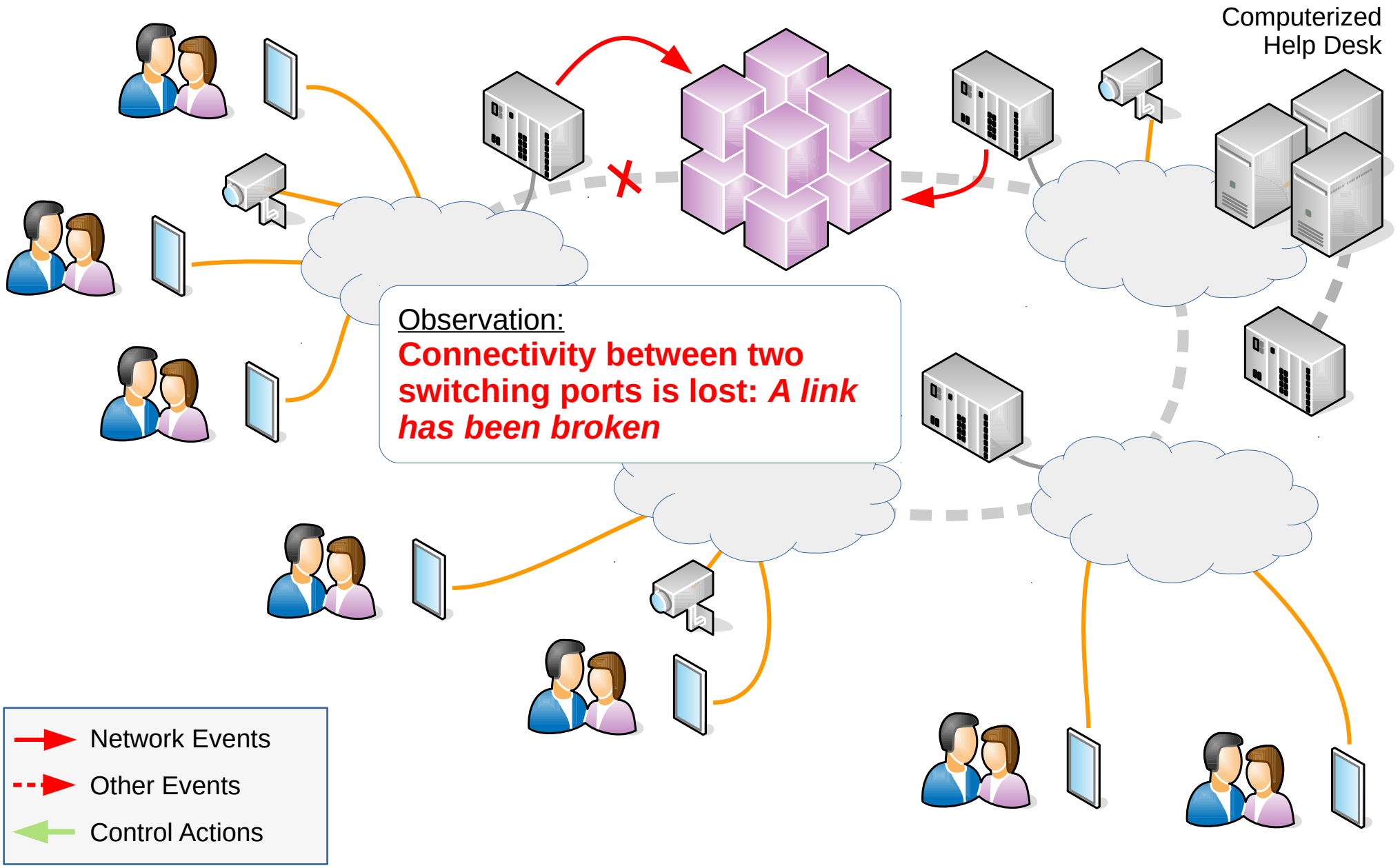
Potential Use Case (III)



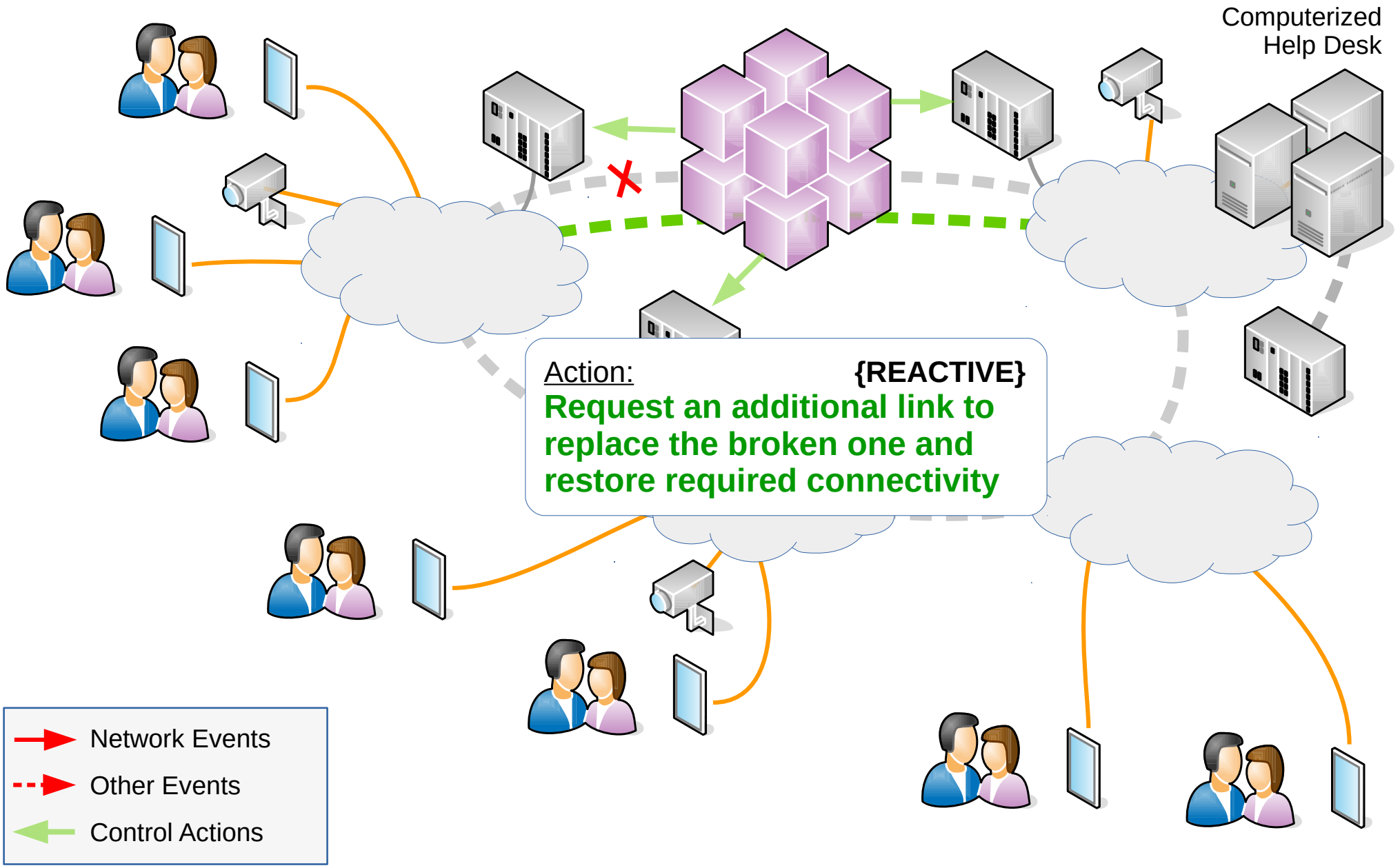
Potential Use Case (IV)



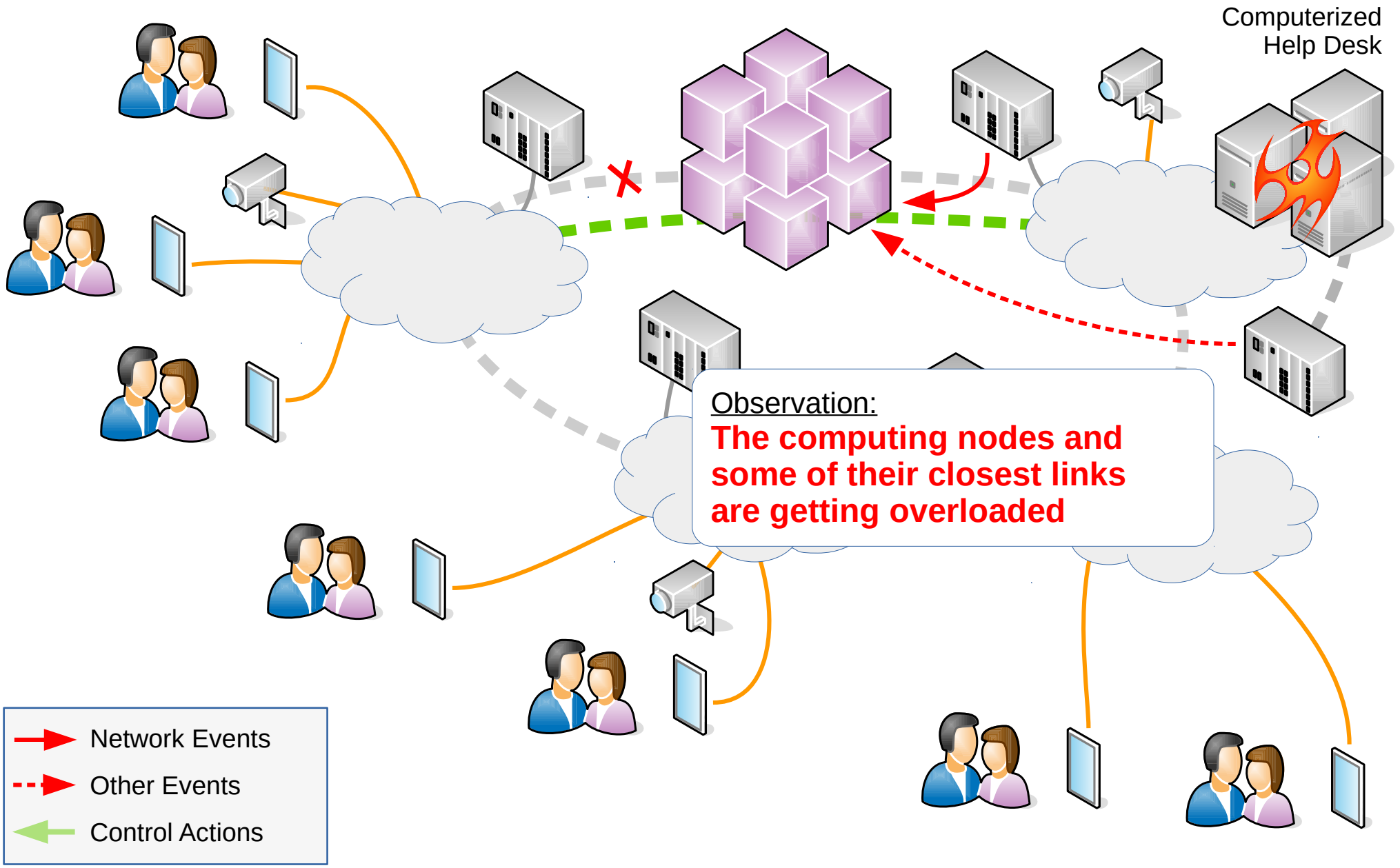
Potential Use Case (V)



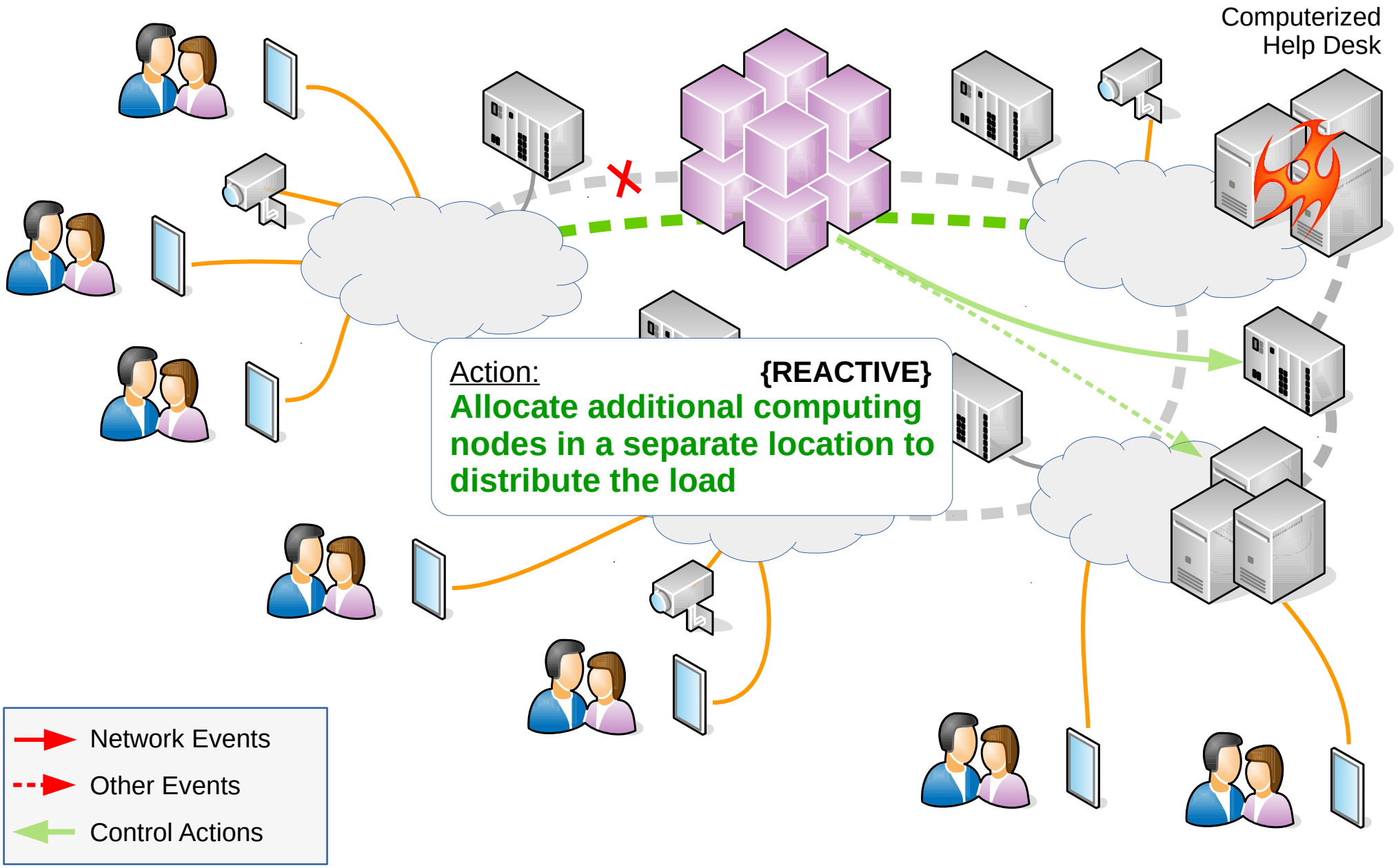
Potential Use Case (VI)



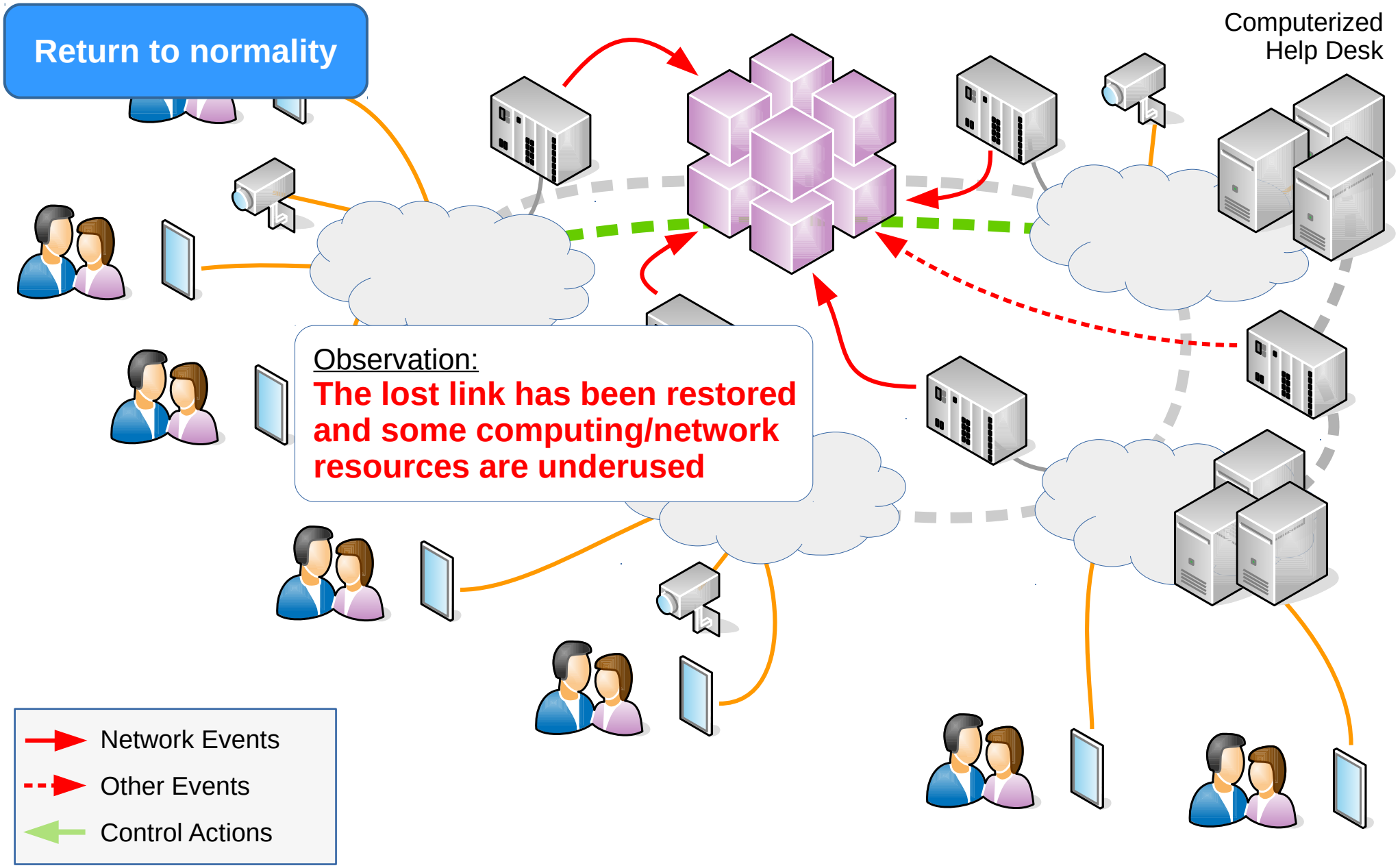
Potential Use Case (VII)



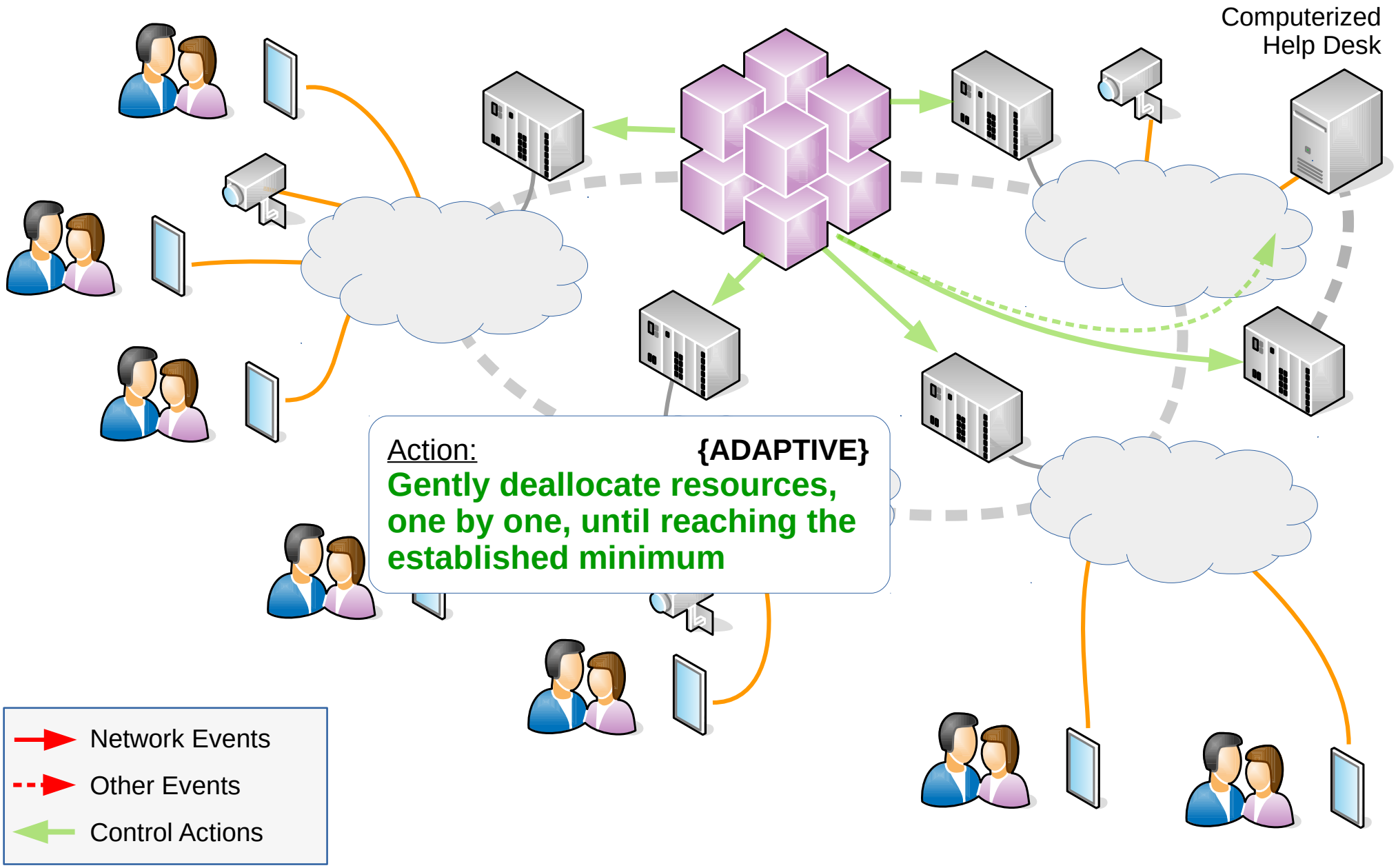
Potential Use Case (VIII)



Potential Use Case (IX)



Potential Use Case (X)



Advanced Scenario (I)

1) Alice wants to account and log the temperature that is around her at any moment, and share it to some of her contacts from her favorite social network.

2) Alice requests:
   - ✔ a link between her mobile phone and her sensor manager,
   - ✔ a temperature sensor for "*the room where she is at any moment*",
   - ✔ a caching service, a router, an authorization service, and a WiFi-AP.

   (*) Each element is requested to the provider that she trusts the most (e.g. the cheapest :-D).

3) Alice somehow (+) builds a composite network service by integrating the elements, both lengthwise (SFC) and crosswise.

4) Alice publishes the service...

(+) It is still unspecified, maybe work-in-progress.

Advanced Scenario (II)

5) Alice then moves to other location:
- It is detected by her mobile phone:
  - An update is triggered to change some parameters:
    - The location of the WiFi AP and sensor, the endpoints of the link...

6) Alice decides to give access to other people from her social network:
- The authorization service gets updated.

7) The workload of the service increases:
- Because it begins to receive much more requests.
- So the appropriate parameters are changed to overcome it:
  - link B/W, cache location and/or replication…

[This use case has been envisioned to represent the exploitation of the main benefits provided by network slicing: ubiquitous flexibility, full virtualization, network service migration, “merging” of computing and network services, etc.]

Technical Viewpoints (I)

- From-Provider-to-Consumer:
  - Providers want to maximize the exploitation of their resources...

    ...which can be physical or virtual, raw or processed.
  - Providers **slice** their infrastructure resources to get a larger set of smaller resources to “sell” to their customers:
    - Resulting resources have, at least, the same capabilities offered by the original resources.
    - The link between the original and resulting resources forms the main **key** of their **management operations**.
  - Applicability to the transport network / VPN:
    - The transport network is sliced into several smaller VPNs.
    - It facilitates comparable properties to its underlying network…

      ...although it does not have all the functions present in the underlying transport,

      ...and it does not provide “plasticity” or high degree of flexibility,

      ...so it is a valid but incomplete method for slicing a transport network.

Technical Viewpoints (II)

- From-Consumer-to-Provider:
  - Consumers want…

    ...to meet their infrastructure requirements,

    ...reduce the cost of their infrastructure,

    ...be able to resize their infrastructure,

    ...and change its configuration,

    ...as fast as possible,
  - Therefore, they…

    ...obtain a slice of resources, possibly from different providers, possibly raw (e.g. L2 link) or processed (e.g. secured tunnel),

    ...and build an overlying service by integrating obtained resources as their main business goal.
  - The **two-hop link** that connects final services to their slice of resources and to the original provider forms the **key** of their **management operations**.
  - Applicability to the transport network / VPN:
    - Consumers do not receive VPN resources “per se” to build their own VPN:
      - They receive VPN "as is" and any change must be requested to the provider.
    - Current VPN model is not able to achieve “plasticity” and fast reaction to changes in the working environment.
      - Which are required by the typical current/future services which are demanding “network slicing”.

Functional Roles (I)

- Infrastructure Provider (InP):
  - Owns the physical or virtual resources:
    - Links, switches, routers, computers, etc.
  - **Slices** the resources to get:
    - Arbitrarily smaller portions => **Increased granularity**.
    - Easy/fast topology/purpose changes => **Enlarged flexibility**.
    - Dynamically specified parameters => **Enlarged plasticity**.
  - Interacts with upper layers (VNO)...

    ...to address their resource requests,

    ...to perform CRUD on those virtual resources.
  - Its main business goal is centered on physical and virtual infrastructure management to address requirements and improving resource efficiency and efficacy.

Functional Roles (II)

- Virtual Network Operator (VNO):
  - Manages slices of virtual resources to build managed (or self-managed) computer and network systems for upper layers.
    - *Packages* InP resources into **Composite Services**.
  - Its main business goal is centered on executing CRUD on VNs.

- Virtual Network Controller (VNC):
  - Main software solution used by VNOs to control their resources through their corresponding underlying infrastructure controllers.

- Recursivity:
  - Some VNOs, consuming InP resources, can offer their resources as if they are InPs, so they support an InP protocol/interface.
  - Example vertical structure:
    - VNO <=> InP+VNO <=> InP+VNO <=> InP.

Functional Roles (III)

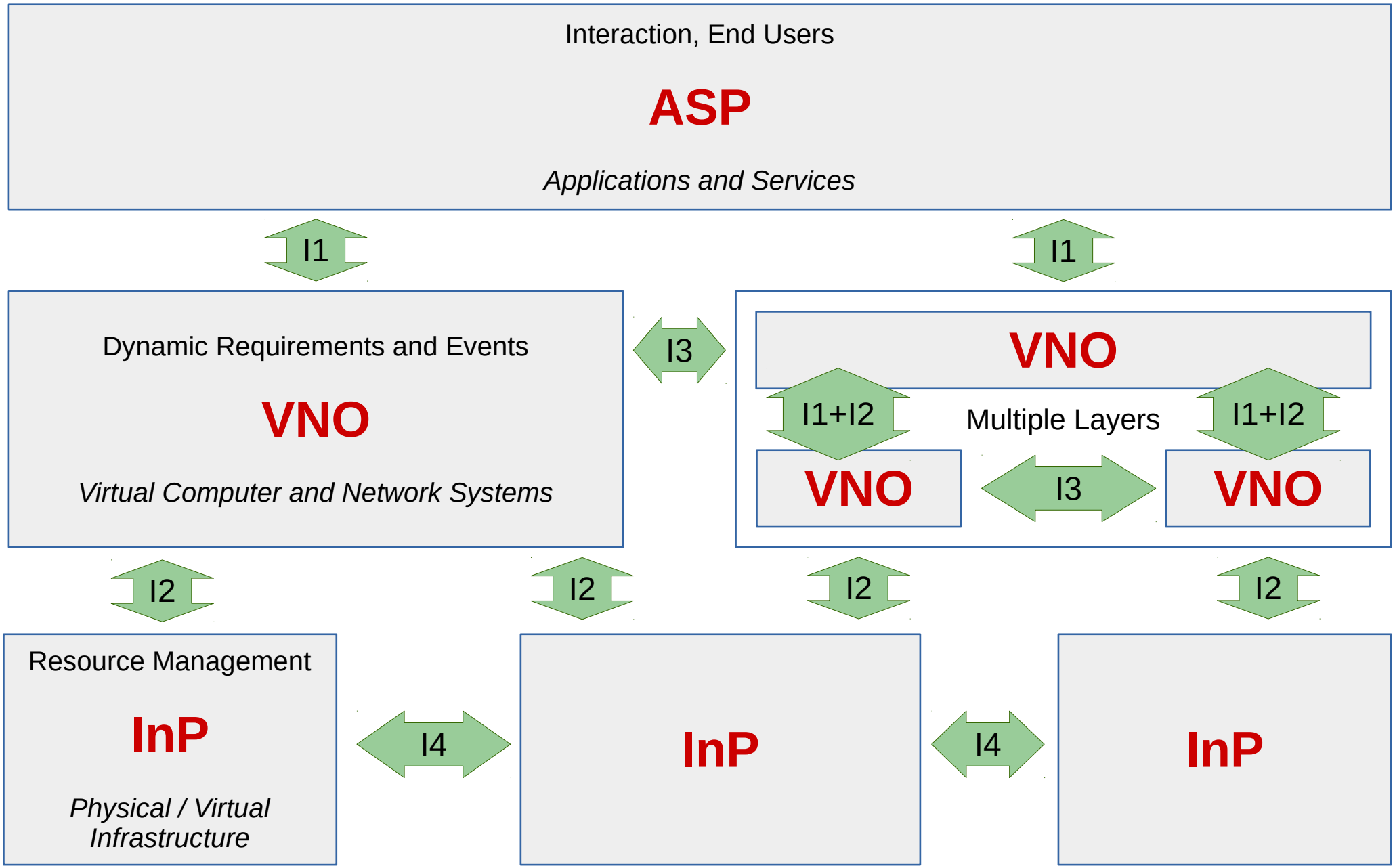
- Application Service Provider (ASP):
  - Interacts with the final users...

    ...or “beneficiaries” of the computer and network system when the actual users would be objects (IoT, M2M).
  - Requests the construction and/or instantiation of network resources or services:
    - Virtual Networks (VNs).
    - Physical/Virtual Network Functions (PNF, VNF).
    - ...
  - Its main business goal is centered on negotiating, managing, and meeting user requirements.

Functional Roles (IV)

- Instantiations:
  - The same entity plays all the roles (InP, VNO, ASP).
  - Two entities, bottom:
    - An entity plays InP and VNO,
    - Other entity plays ASP.
  - Two entities, top:
    - An entity plays InP,
    - Other entity plays VNO, ASP.
  - Each role is played by a separated entity.
- Multiple, vertical VNOs (recursivity) is usually found in the last combination.

Viewpoints, Roles, and Interfaces



Interfacing Requirements

- VNO <=> ASP: I1
  - ASP requests to CRUD on Vns.

- InP <=> VNO: I2
  - Allows the VNO to manage the “slice” of network resources from a provider.
    - Vertical interaction to request and instantiate (embed) virtual networks (VNs) onto the underlying physical infrastructure.
  - Possibly recursive when a VNO also acts as InP.

- VNO <=> VNO: I3
  - Allows VNOs to coordinate:
    - Inter-operator tasks (e.g. resource migration) requested by ASPs.
    - Interconnection and interoperability among VNs of different operators.
  - Horizontal (non-recursive) communication between virtual operators.

(?) InP <=> InP: I4
  - Horizontal communication between providers to coordinate the interaction among physical, infrastructure resources, and/or the migration of VNs among InPs.

Thanks for your attention

Q & A

– EOF –