

The Design of Network Services for Advanced Collaborative Environment

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Outline

- Review
 - Assumption of advanced collaborative environments
 - Goals of network services
- Examples
- The Design of Network Service
 - Properties of network services
 - CENSA and CENSI
- General Approach
- Current and Future Work
- Summary

Assumptions of ACE

- Higher network transmission rate
- Higher computational power
- Higher scalability
- Higher portability

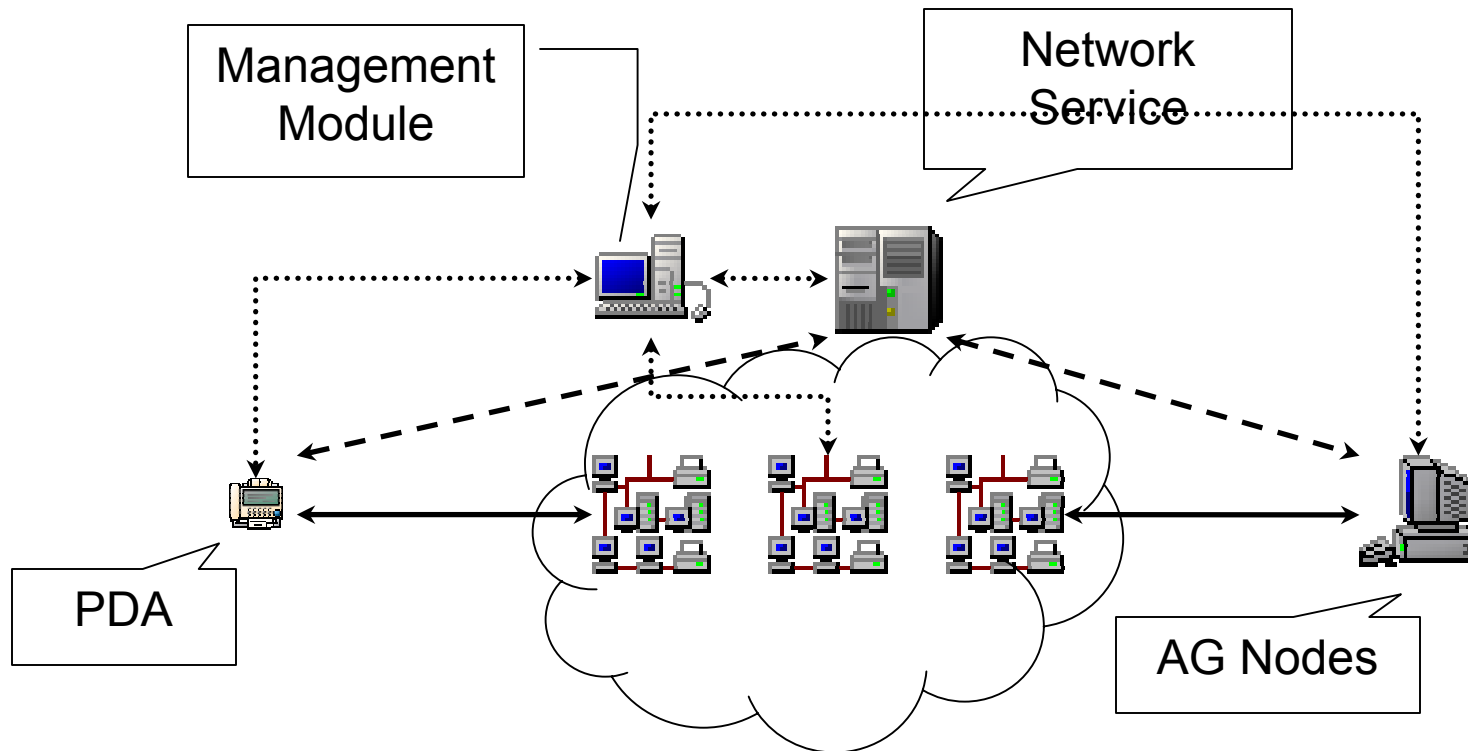
Limitations of Current CE

- Resource Constraints
 - Computing power, bandwidth
 - Hardware, software component
 - Various systems
- Location constraints
- Perceptions of presence

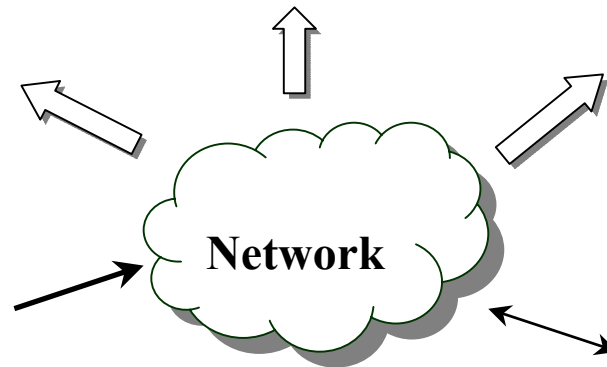
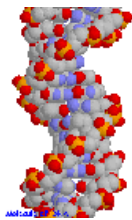
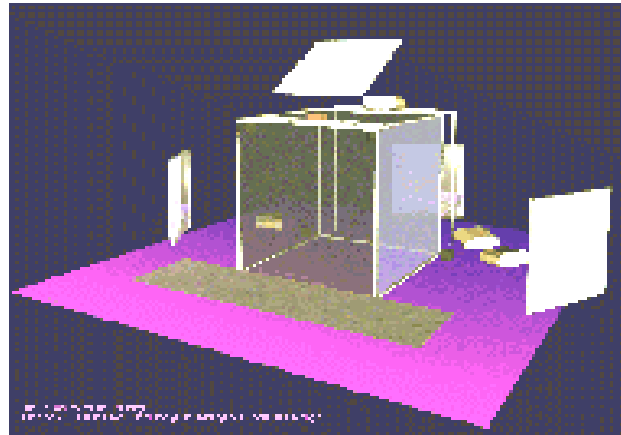
Goals of Network Services

- Seamless integration
- Free of location constraints
- Relaxing resource constraints
- Multi-platform support
- Quality of service (QoS)

Example 1



Example 2

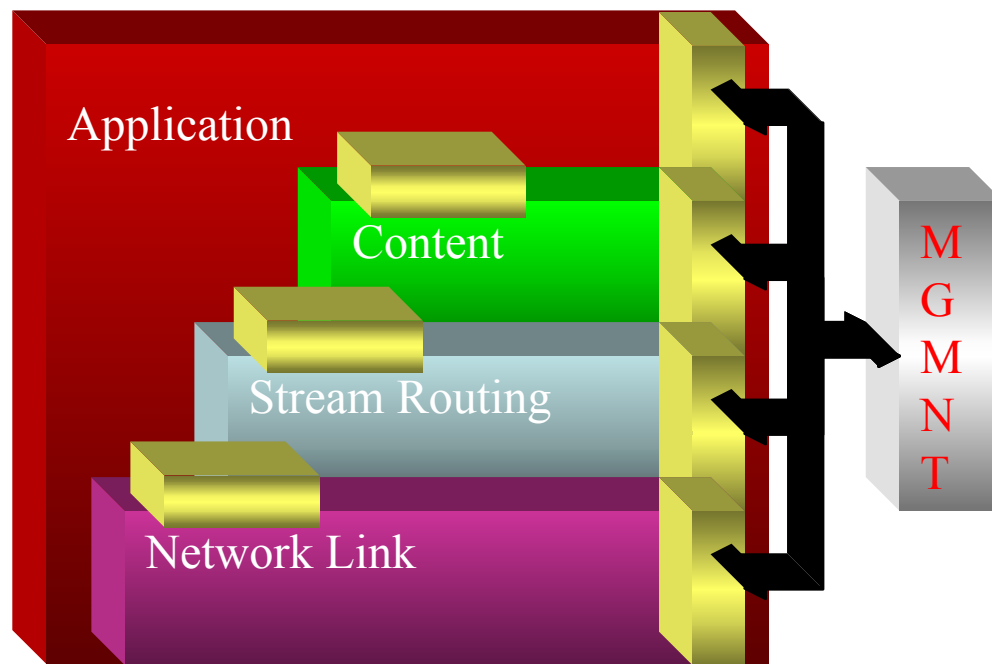


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Properties of Network Service and Network Service Architecture

- Properties of network service
 - Network service as a network resource object
 - Decentralization
 - Heterogeneous conditions
- Properties of network service architecture
 - Soft-state
 - Decentralization
 - Self-adaptable
 - Transparent
 - Stream-Capability

Network Service Architecture

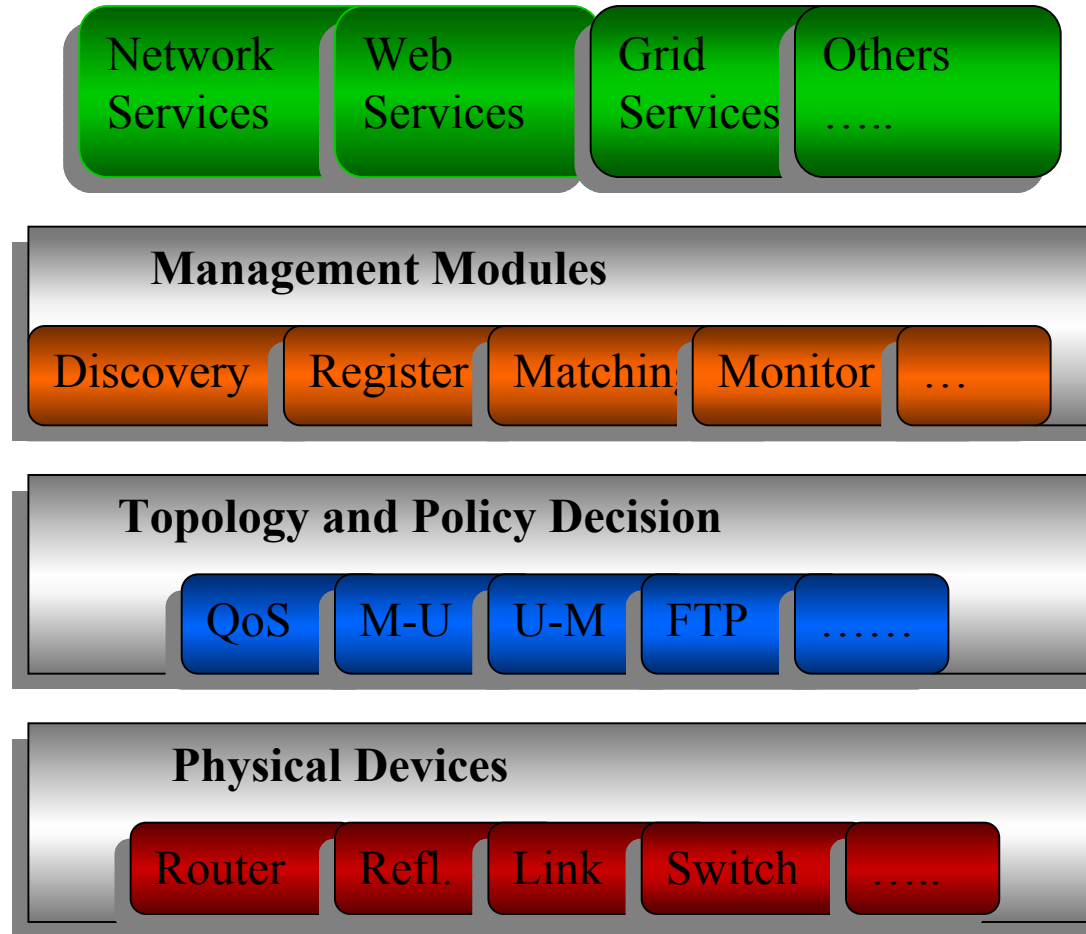


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Network Service Architecture

- Applications
 - Resource, networks, ...
- Content-Interceptor
 - description files defined by specific schemas
- Stream Route
 - Finding optimal streaming topology
- Network Links
 - Routers, Bridges, ...

Network Service Infrastructure



General Approach: Capability Description Schema

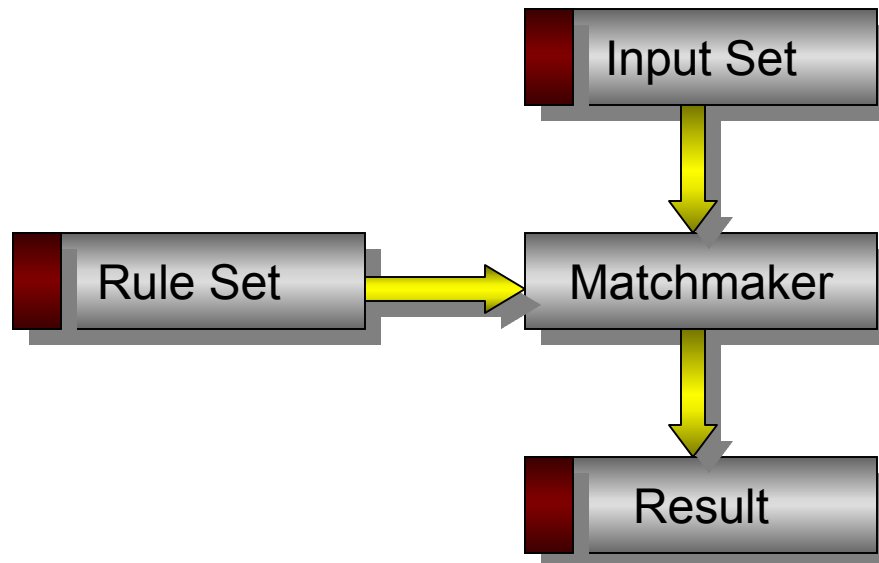
- Capability Space and Capability Vector:

$$\vec{v} = (v_1, v_2, \dots, v_n) \in R^n$$

- Network Service as Transformation Matrix:

$$\vec{v}_1 = T\vec{v}_2$$

General Approach: General Matchmaker



General Approach: Matching Algorithm

- Finding the best service in two sets:

$$T_{1,2} = T(S_1^n, S_2^n) = [T_{i,j}]_{\max\|\vec{v}_{1,i}\|}, \quad \text{where } \vec{v}_{1,i} = T_{i,j} \vec{v}_{2,j}$$

- Finding a set of services for multi-sets:

$$S_1^n, S_2^n, \dots, S_k^n, S_i^n \subseteq R^n, i = 1, \dots, k.$$

$$\vec{S}_1^n \perp \vec{S}_2^n \perp \dots \perp \vec{S}_l^n, l \leq k$$

$$\{T_{1,2}, T_{1,3}, \dots, T_{i,j}, \dots, T_{l-1,l}\}, \text{ where } T_{i,j} = T(\vec{S}_i^n, \vec{S}_j^n)$$

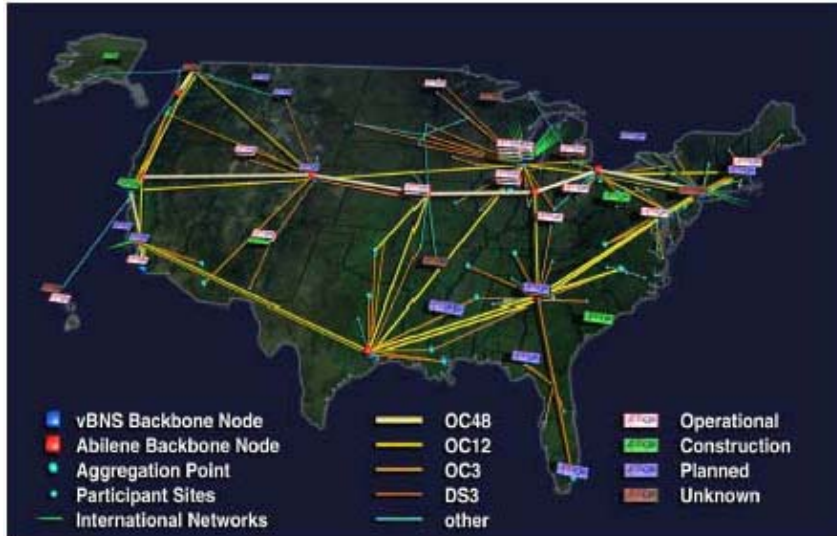
General Approach: Matching Algorithm (cont.)

- Our goal is the best common resolution vector and corresponding transformation matrices.

$$(\vec{v}^*, T^*) = \begin{cases} (\operatorname{argmax}\{\vec{v}_i \mid \vec{v}_i \in S^*\}, \Phi), S^* \neq \Phi \\ (\operatorname{argmax}\{\vec{v}_i \mid \vec{v}_i \in S^{**}\}, T^*), S^* = \Phi, S^{**} \neq \Phi \end{cases}$$

$$T^* = \{T_{1,2}, T_{1,3}, \dots, T_{i,j}, \dots, T_{l-1,l}\}, T_{i,j} = T(\vec{S}_i^n, \vec{S}_j^n), i, j = 1, \dots, l$$

General Approach: Stream Topology



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General Approach: Stream Topology Algorithm

- Active unconnected session:

$$G(V, E)$$

- We borrow nodes from non-active session to comprise a connected graph:

$$G''(V'', E'')$$

- Finding the minimum cost connected graph:

$$C_{opt} = \min_{V'', E''}(C(G''(V'', E''))))$$

Current Work: Schema Design

```
<?xml version="1.0"?>
```

```
<!-- EXAMPLE FOR AUDIO TYPE -->
```

```
<c>
```

```
  <a n="type"><s>audio</s></a>
```

```
  <a n="preference"><l>
```

```
    <s>L16-48K-Stereo</s>
```

```
  </l>
```

```
  <a n="SampleRate"><l>
```

```
    <l><n>8</n>
```

```
    <s>L16-8K-Mono</s>
```

```
    <s>L16-8K-Stereo</s>
```

```
    .....
```

```
  <a n="BitRate"><l>
```

```
    <l><n>5.6</n>
```

```
    <s>LPC-8K-Mono</s></l>
```

```
    <l><n>13.2</n>
```

```
    <s>GSM-8K-Mono</s>
```

```
    .....
```

```
R1 = [
```

```
  type="audio";
```

```
  preference="L16-48K-Stereo";
```

```
  n="SampleRate"><l>
```

```
    <l><n>8</n>
```

```
    <s>L16-8K-Mono</s>
```

```
    <s>L16-8K-Stereo</s>
```

```
    <s>L8-8K-Mono</s>
```

```
    .....
```

```
  <a n="BitRate"><l>
```

```
    <l><n>5.6</n>
```

```
    <s>LPC-8K-Mono</s></l>
```

```
    <l><n>13.2</n>
```

```
    <s>GSM-8K-Mono</s>
```

```
    <l><n>16.0</n>
```

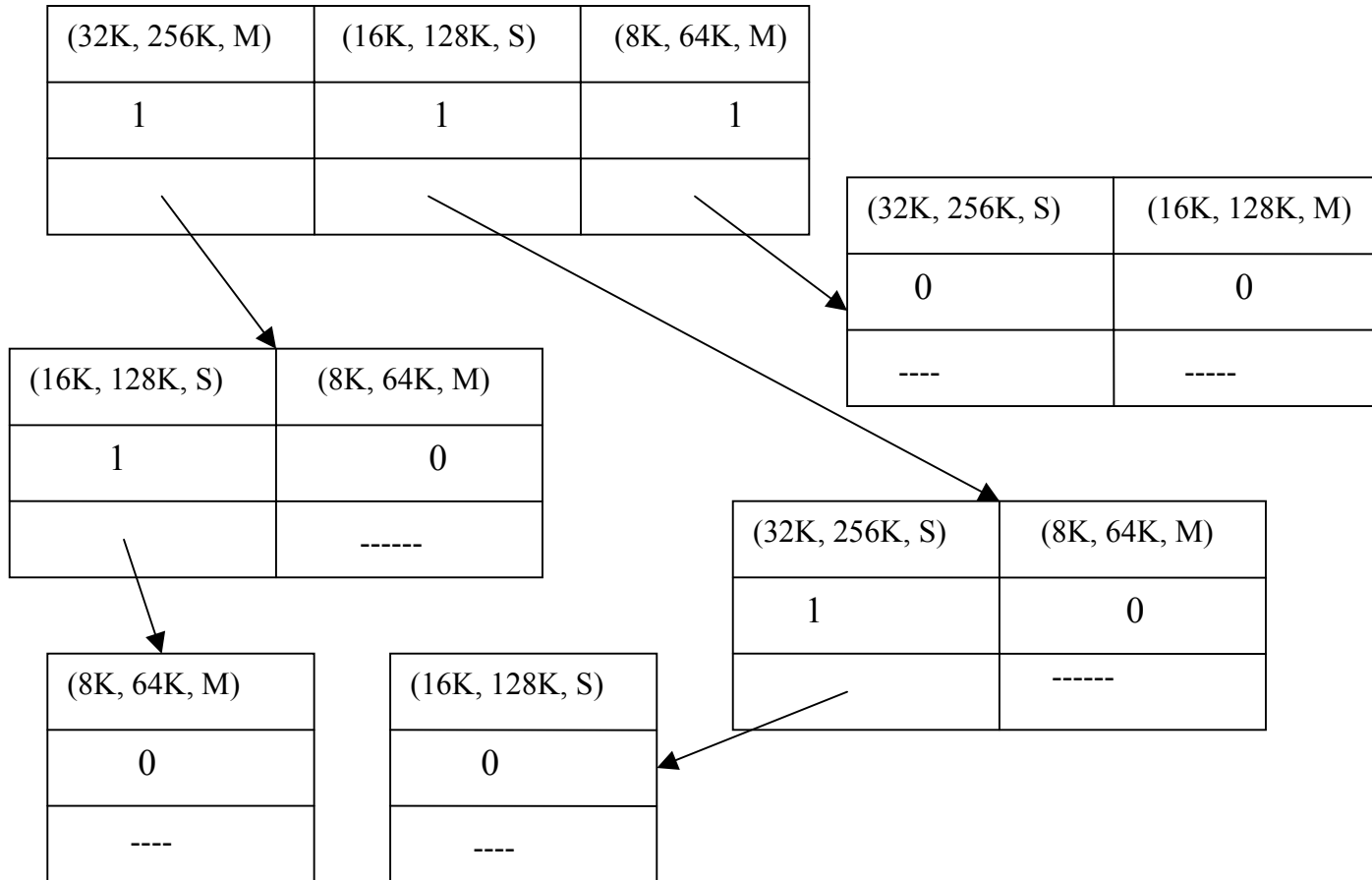
```
    <s>G726-16-8K-Mono</s>
```

```
    <l><n>24.0</n>
```

```
    <s>G726-24-8K-Mono</s></l>
```

```
    .....
```

Current Work: Matching Algorithm



Current Work: Multicast Beacon Analysis

0.8.15_Debug_updated 1056171529 Fri Jun 20 23:58:49 2003

nbeacons 102

beacon 0 admins@elcan.utcc.utoronto.ca 128.100.102.45

beacon 1 beacon@129-7-249-150.dhcp.uh.edu 129.7.249.150

beacon 2 beacon@access2.ca.sandia.gov 146.246.172.2

... ..

```
1 NA 0.0/0.0/0.0/0.0/0.0 146353.0/1.0/0.0/0.0/0.0 146329.0/0.2/0.0/0.0/0.0 146334.0/8574.3/99/0.0/0.0
  146345.0/9.3/0/0.0/0.0 NA NA 146335.0/0.9/0/0.0/0.0 NA 146329.0/0.4/0/0.0/0.0 146326.0/0.4/0/0.0/0.0
  146334.0/1.0/0/0.0/0.0 146340.0/0.4/0/0.0/0.0 146332.0/0.9/0/0.0/0.0 146370.0/0.8/0/0.0/0.0
  146350.0/1.2/0/0.0/0.0 NA 146347.0/0.5/0/0.0/0.0 2730494.0/2.3/0/0.0/0.0 146349.0/0.3/0/0.0/0.0 NA NA NA
  268594.0/7.2/0/0.0/0.0 NA 146331.0/0.2/0/0.0/0.0 146339.0/1.9/0/0.0/0.0 146391.0/4.3/0/0.0/0.0
  146335.0/1.0/0/0.0/0.0 140680.0/3.5/0/0.0/0.0 NA -2697617.0/1.7/0/0.0/0.0 -6067680.0/2.7/0/0.0/0.0
  4319956.0/0.4/0/0.0/0.0 146341.0/1.2/0/0.0/0.0 146338.0/8574.6/100/0.0/0.0 146329.0/1.5/0/0.0/0.0
  146332.0/0.3/0/0.0/0.0 NA 146356.0/0.6/0/0.0/0.0 115929.0/7.8/0/0.0/0.0 NA 836505.0/2.2/0/0.0/0.0
  146330.0/8574.0/99/0.0/0.0 NA 146332.0/1.5/0/0.0/0.0 139177.0/1.6/0/0.0/0.0 NA -693516.0/0.4/0/0.0/0.0
  146426.0/0.5/0/0.0/0.0 146318.0/0.8/0/0.0/0.0 NA NA 792032.0/0.9/0/0.0/0.0 0.0/9146.6/0/0.0/0.0 NA
  146329.0/0.7/0/0.0/0.0 NA 146359.0/1.1/0/0.0/0.0 750071.0/1.9/0/0.0/0.0 146169.0/1.2/0/0.0/0.0
  146362.0/4.4/2/0.0/0.0 3583465.0/0.9/0/0.0/0.0 0.0/9146.4/0/0.0/0.0 100010.0/2.3/0/0.0/0.0 146389.0/0.3/0/0.0/0.0
  146330.0/1.6/0/0.0/0.0 146320.0/2.6/0/0.0/0.0 146332.0/2.0/0/0.0/0.0 146334.0/0.7/0/0.0/0.0
  146341.0/1.4/0/0.0/0.0 NA 0.0/376154.2/0/0.0/0.0 146323.0/0.8/0/0.0/0.0 0.0/440668.5/0/0.0/0.0 NA
  146329.0/0.5/0/0.0/0.0 1144773.0/1.0/0/0.0/0.0 46107.0/0.3/0/0.0/0.0 246985.0/1.1/0/0.0/0.0
  139996.0/0.5/0/0.0/0.0 NA NA 1523510.0/0.3/0/0.0/0.0 0.0/168601.0/0/0.0/0.0 413942.0/1.1/0/0.0/0.0
  146335.0/0.3/0/0.0/0.0 146340.0/3.1/0/0.0/0.0 50653.0/4.5/0/0.0/0.0 NA 146453.0/0.7/0/0.0/0.0
  146354.0/2.0/0/0.0/0.0 146327.0/1.0/0/0.0/0.0 NA NA NA 146330.0/0.7/0/0.0/0.0 390524.0/1.3/0/0.0/0.0 NA
  311661.0/18261.6/100/0.0/0.0 NA NA
```

Future Work

- Implementation of general matcher
- Multicast Beacon Data Analysis
- Implementation of stream topology algorithm
- Integration of network service architecture

Summary

- Properties of network service
- Novel proposal of network service architecture and infrastructure
 - CENSA and CENSI
- General approach
 - Capability description schema
 - General matchmaker
 - Matching algorithm
 - Multicast beacon data analysis
 - Stream topology algorithm