

A Novel Approach for Service Function Chain (SFC)Mapping with Multiple SFC instances in a Fog-To-Cloud Computing System

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Outline

1 Introduction

- Internet of Things (IoT)
- Cloud computing
- Fog computing
- Fog-to-Cloud computing system
- Software Defined Network and network function virtualization
- Related Work

2 System Model

- Problem statement
- Modeling
- Objective function
- Constraints

3 Numeric Results

4 Second Section

- IoT

- interconnects billions or even trillions of diverse devices

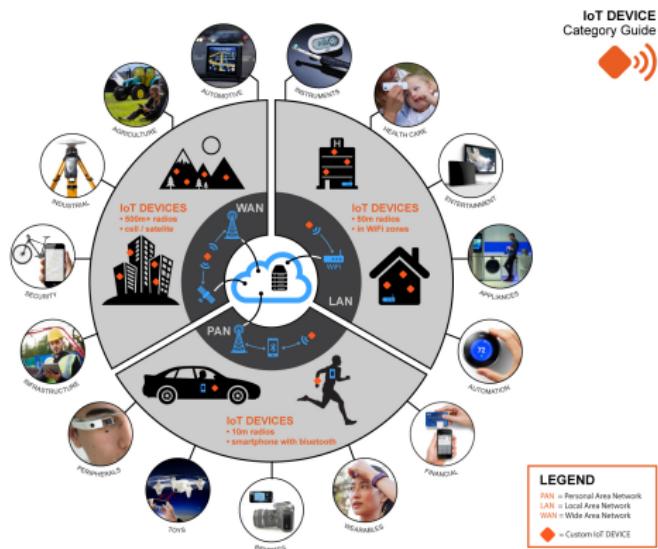


Figure: IoT devices

• IoT

- interconnects billions or even trillions of diverse devices
- generate a massive amount of data

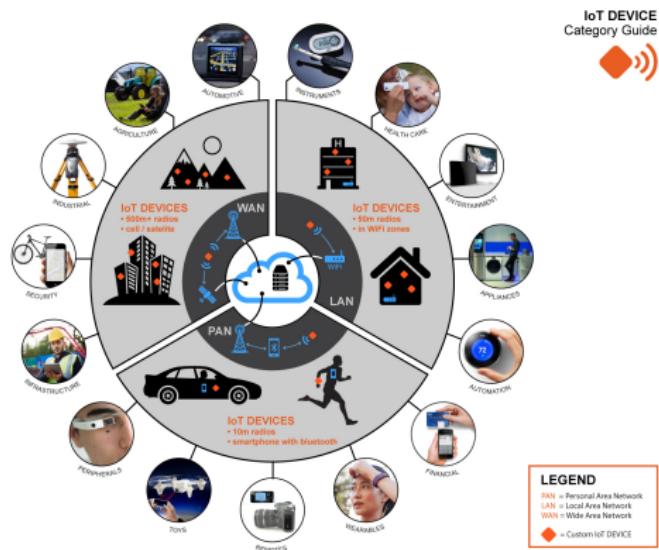


Figure: IoT devices

• IoT

- interconnects billions or even trillions of diverse devices
- generate a massive amount of data
- should be transmitted to the cloud for computing

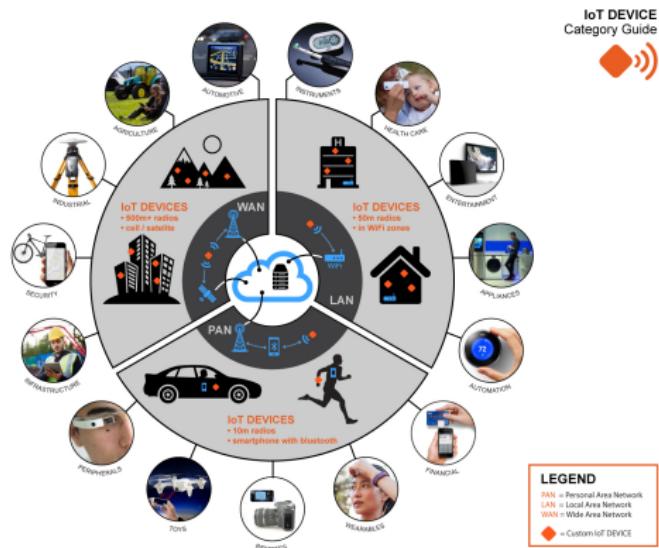


Figure: IoT devices

- Cloud computing
 - cloud offers various benefits such as scalability and elasticity



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 - consolidation and centralization lead to many network hops



Figure: Cloud computing

- Cloud computing
 - cloud offers various benefits such as scalability and elasticity
 - consolidation and centralization lead to many network hops
 - results in high latencies and high bandwidth consumption



Figure: Cloud computing

- Healthcare



Figure: Healthcare

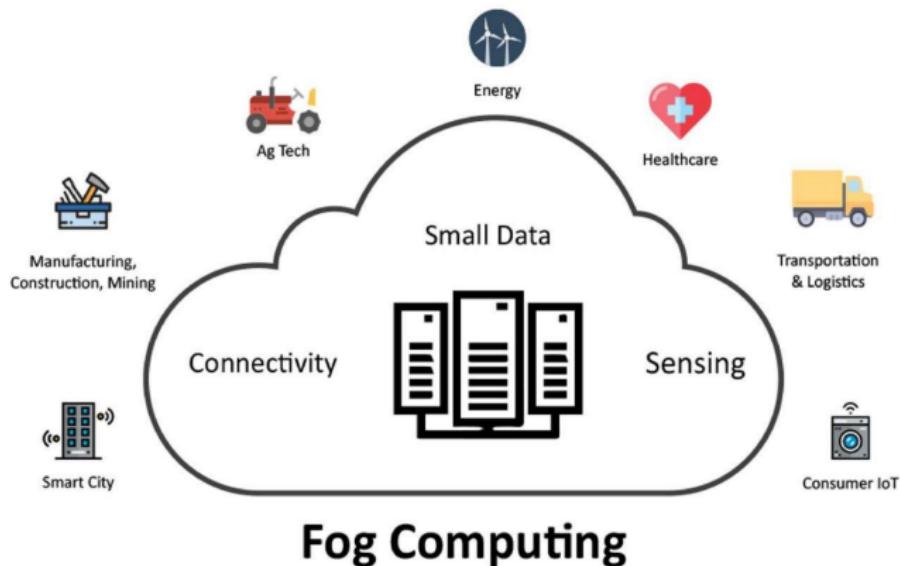
- Augmented reality



Figure: Augmented reality

- Fog computing

- offers distributed edge cloud close to the Things



- Fog-to-Cloud computing system
 - fog and cloud work together

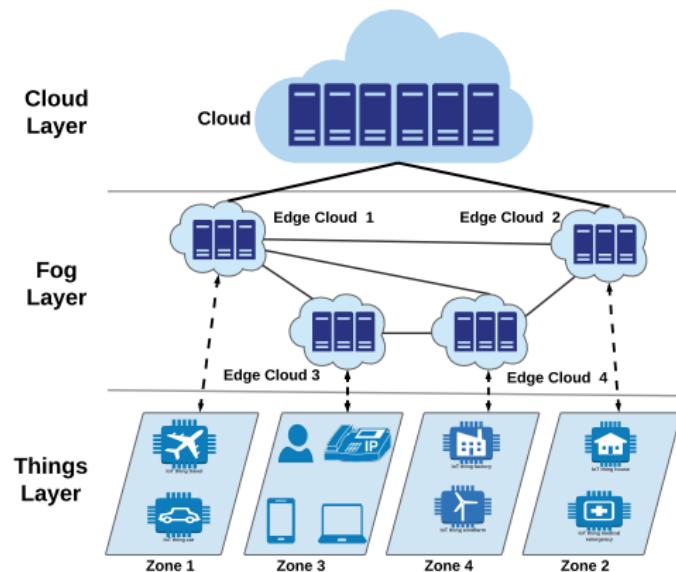


Figure: Fog-to-Cloud computing system

- Fog-to-Cloud computing system
 - fog and cloud work together
 - provide computing, storage, and application services in the IoT domain

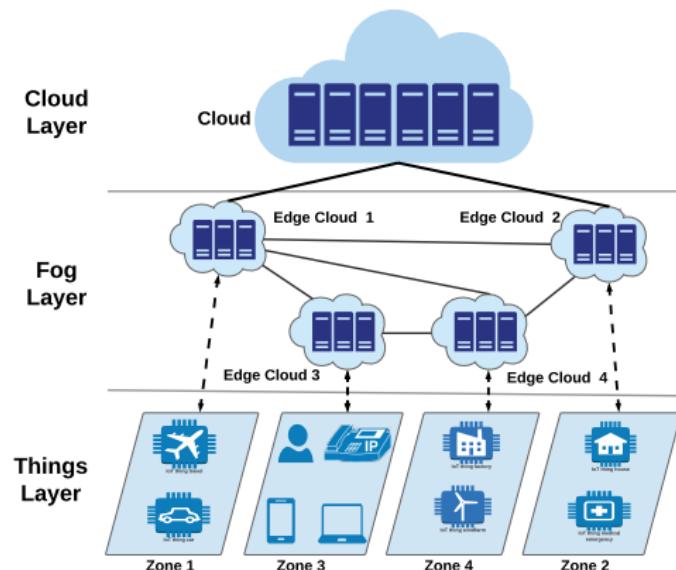


Figure: Fog-to-Cloud computing system

- Fog-to-Cloud computing system
 - fog and cloud work together
 - provide computing, storage, and application services in the IoT domain
 - complex management of such a network of distributed fogs

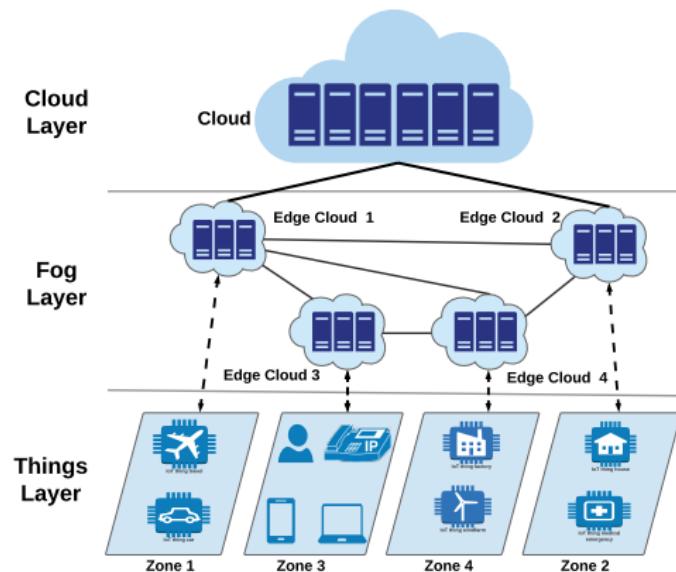


Figure: Fog-to-Cloud computing system

- Software Defined Network(SDN)
 - SDN separates the control and data planes



Figure: Software Defined Network

- network function virtualization(NFV)
 - NFV reshapes dedicated hardware functionality

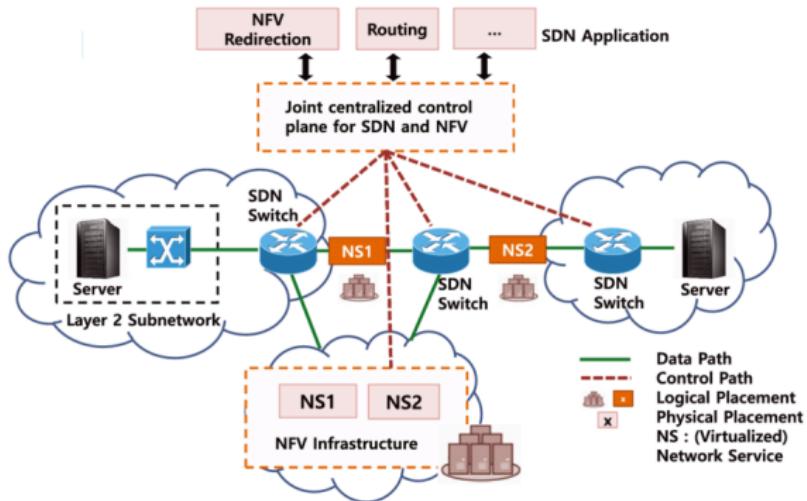


Figure: SDN based network with support for NFV

- network function virtualization(NFV)
 - NFV reshapes dedicated hardware functionality
 - software modules named virtual network functions (VNFs)

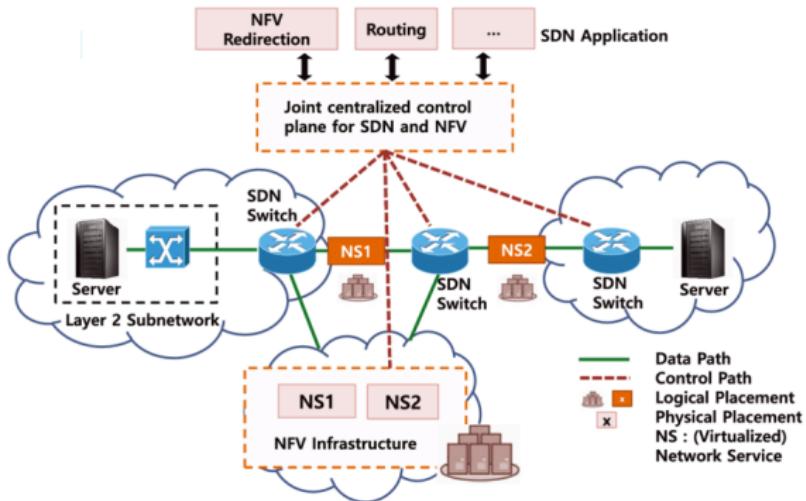


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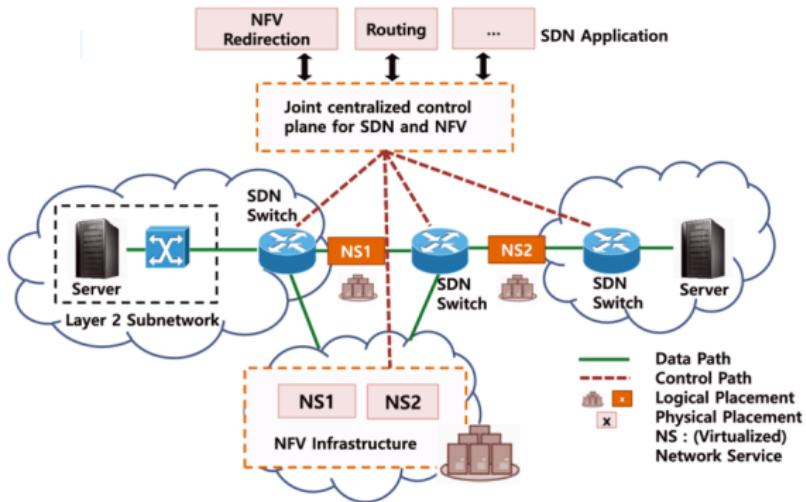


Figure: SDN based network with support for NFV

- network function virtualization(NFV)
 - NFV reshapes dedicated hardware functionality
 - software modules named virtual network functions (VNFs)
 - agile and scalable service placement
 - reducing Capital Expenditure (CAPEX) and Operation Expense (OPEX)

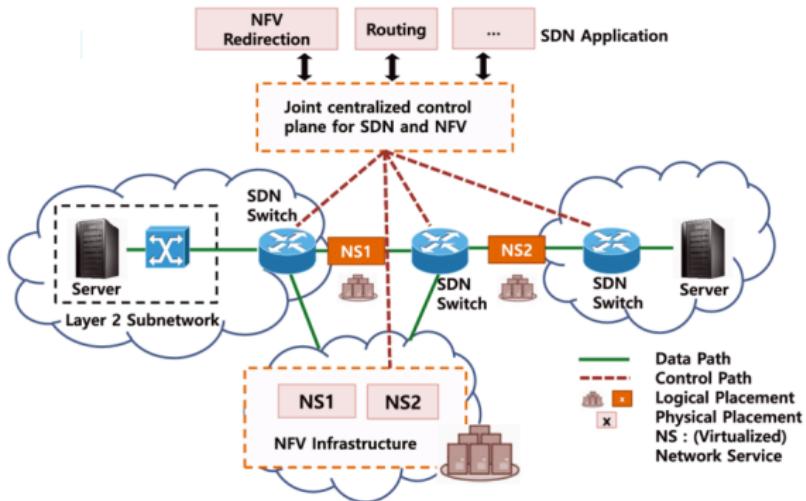


Figure: SDN based network with support for NFV

- Service Function Chaining(SFC)
 - specific set of VNFs

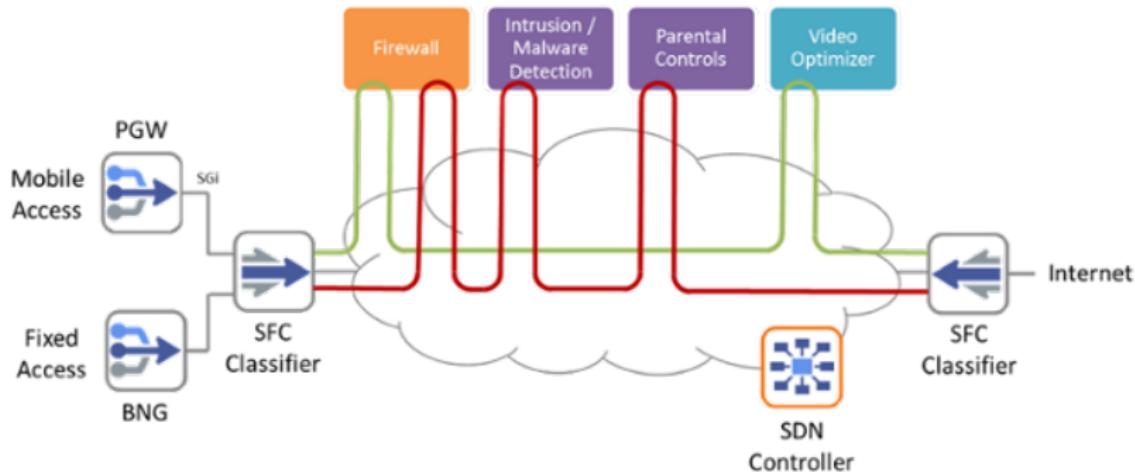


Figure: Service Function Chaining

- Service Function Chaining(SFC)

- specific set of VNFs
- joint VNF placement and traffic routing are called SFC mapping

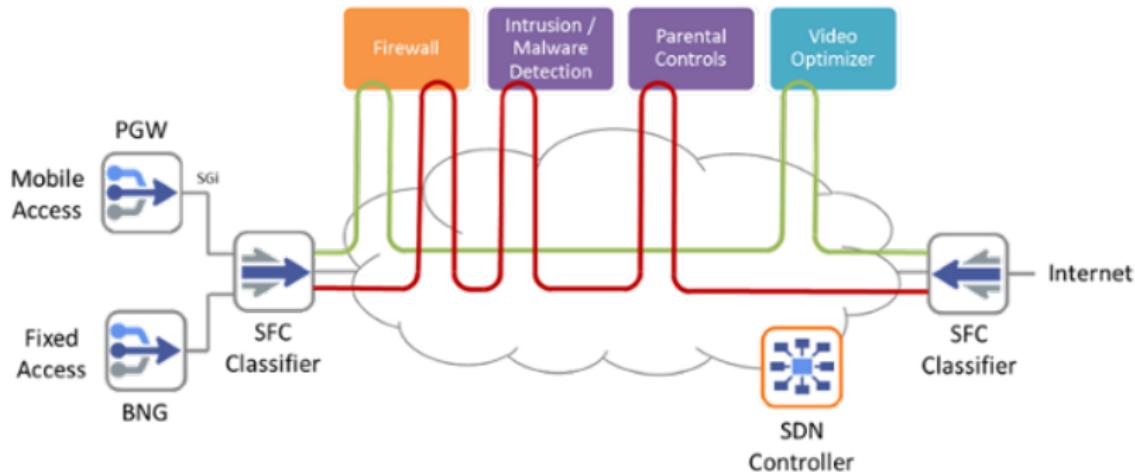


Figure: Service Function Chaining

Author	Year	Mapping	Solution	Objective
Draxler	2017	VNFs mapping	heuristic and exact	total data rate and total latency
Huin	2018	Placement	exact	total latency
Masri	2017	Select optimal fog or cloud	exact	total latency
Fan	2017	Task scheduling in a fog-to-cloud computing system	heuristic	maximizing the profits of fog service provider
Gupta	2017	VNFs mapping	ILP column -generation based model	bandwidth consumption

Table: Related Work

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- we propose an ILP solution that provides the exact solution for SFC mapping in the F2C architecture
- in order to minimize total latency of network
 - the number of instances for each SFC and replicas for each VNF are considered

- Problem statement
 - network topology



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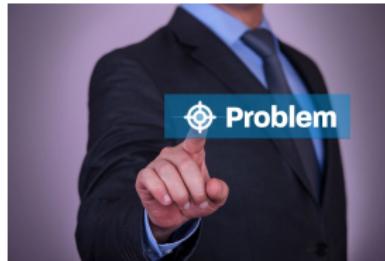
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- users SLA
- instances number
- placement of VNFs
- corresponding traffic routing



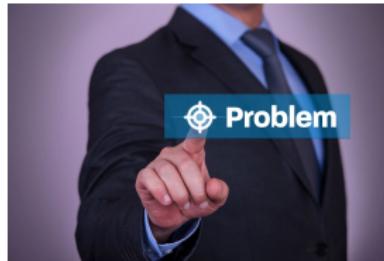
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- corresponding traffic routing
- users assignment to the SFC instances



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- traffic flows between two pairs of fog or fogs and cloud requiring a specific SFC
- users SLA
- instances number
- placement of VNFs
- corresponding traffic routing
- users assignment to the SFC instances
- minimize overall latency of network



- Service Function Chaining (SFC)

$$[SFC\ c] \quad f_{\sigma_1(c)} \rightarrow f_{\sigma_2(c)} \rightarrow \cdots \rightarrow f_{\sigma_{n_c}(c)} \quad (1)$$

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- generate all configurations of each SFC $c \rightarrow \hat{\Gamma}_c$
- aggregation of all configuration of SFCs $\rightarrow \hat{\Gamma}$
- Each configuration ($\hat{\gamma}$) of SFC c is characterized by:
 - Location of VNFs $\rightarrow a_{vi}^{\hat{\gamma}}$

Paragraphs of Text

Bullet Points

- Lorem ipsum dolor sit amet, consectetur adipiscing elit
- Aliquam blandit faucibus nisi, sit amet dapibus enim tempus eu
- Nulla commodo, erat quis gravida posuere, elit lacus lobortis est, quis porttitor odio mauris at libero
- Nam cursus est eget velit posuere pellentesque
- Vestibulum faucibus velit a augue condimentum quis convallis nulla gravida

Blocks of Highlighted Text

Block 1

 Lorem ipsum dolor sit amet, consectetur adipiscing elit. Integer lectus nisl, ultricies in feugiat rutrum, porttitor sit amet augue. Aliquam ut tortor mauris. Sed volutpat ante purus, quis accumsan dolor.

Block 2

 Pellentesque sed tellus purus. Class aptent taciti sociosqu ad litora torquent per conubia nostra, per inceptos himenaeos. Vestibulum quis magna at risus dictum tempor eu vitae velit.

Block 3

 Suspendisse tincidunt sagittis gravida. Curabitur condimentum, enim sed venenatis rutrum, ipsum neque consectetur orci, sed blandit justo nisi ac lacus.

Multiple Columns

Heading

- ① Statement
- ② Explanation
- ③ Example

Lorem ipsum dolor sit amet,
consectetur adipiscing elit. Integer
lectus nisl, ultricies in feugiat rutrum,
porttitor sit amet augue. Aliquam ut
tortor mauris. Sed volutpat ante
purus, quis accumsan dolor.

Table

Treatments	Response 1	Response 2
Treatment 1	0.0003262	0.562
Treatment 2	0.0015681	0.910
Treatment 3	0.0009271	0.296

Table: Table caption

Theorem

Theorem (Mass–energy equivalence)

$$\underline{E = mc^2}$$

Verbatim

Example (Theorem Slide Code)

```
\begin{frame}  
 \frametitle{Theorem}  
 \begin{theorem}[Mass--energy equivalence]  
 $E = mc^2$  
 \end{theorem}  
 \end{frame}
```

Figure

Uncomment the code on this slide to include your own image from the same directory as the template .TeX file.

Citation

An example of the \cite command to cite within the presentation:

This statement requires citation [Smith, 2012].

References



John Smith (2012)

Title of the publication

Journal Name 12(3), 45 – 678.

The End