

Preliminary Title

Preliminary Description

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Abstract

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1 Introduction

There are many paradigms of commercial sensor management and monitoring. Organizations can use anything from PLC (programmable Logic Controllers) to IoT devices to manage and monitor their sensors. For commercial use some of these alternatives are more popular than others. There are also a large amount of different higher level protocols like MQTT, HTTP and SNMP that can be used to manage and monitor sensors. We propose using the NETCONF protocol with YANG sensor models for management. This work will be done in collaboration with Lightside Instruments AS.

This document will cover the following three topics:

- **Work Methodology:** An indept analysis of the knowledge base around work methods like Scrum, Kanban, and Waterfall. With a focus on how our work methodology differs from these.
- **NETCONF and YANG sensor management:** A qualitative analysis of the NETCONF and YANG protocols and how they can be used to manage sensors.
- **NETCONF Security:** A qualitative analysis of the security aspects of the NETCONF protocol.

Writer's note:
unprecise, replace: "can use anything from..." and all other vague statements.

2 Lightside Instruments AS

Lightside Instruments is a company specializing in developing instruments with model based network management for use in networking, network interconnect testing and telemetry. They design their instruments with YANG (RFC7950) [6] models and NETCONF (RFC6241) [11] protocol. The instruments are based on IETF standards and drafts, and are implemented with software tools available in Debian, programmable logic and open hardware [20].

3 Technical background

3.1 NETCONF and YANG

NETCONF [11] is a model based Network Configuration Protocol. Each NETCONF device presents the aquiring device with a YANG [6] data model

consisting of the device state and parameters. Each data model has a set of constraints making them error correcting.

3.2 Node-RED

Node-RED [21] is an open source low code programming tool for event driven applications. It is developed by IBM and is based on Node.js [24]. Node-RED is used to connect hardware devices and APIs through a visual programming interface.

3.3 Grafana

Grafana [15] is an open source data visualization tool. It is used to visualize arbitrary data from different data sources.

3.4 Scrum

Scrum [16] is a framework for agile [5] software development.

3.5 Kanban

Kanban [18] is a framework for agile software development.

3.6 Waterfall

Waterfall [33] is a framework for software development.

3.7 Extreme Programming

Extreme Programming [12] is a framework for agile software development.

4 Work Methodology

4.1 Research Question

This review examines the claims that Scrum, Kanban, Waterfall, Extreme Programming and DevOps increases worker productivity substantiated by empirical evidence.

4.2 Scoping Review

4.2.1 Search strategy

The following is our search strategy for the scoping review. We will be searching for quantitative studies on the efficiency of the following work methodologies:

- Scrum
- Kanban
- Waterfall
- Extreme Programming
- DevOps

We will be searching the following databases:

- IEEE Xplore [17]
- ACM Digital Library [3]
- Google Scholar [14] (Meta database)

We will also be searching the following industry websites:

- Agile Alliance [4]
- Scrum.org [16]
- DevOps Institute [25]
- Scrum Alliance [30]

Our search will consist of a set of primary and secondary keywords. The primary keywords are:

- Scrum
- Kanban
- Waterfall

Writer's note:
This section becomes a bit monotone, consider fewer lists.

- Extreme Programming
- DevOps

The secondary keywords are:

- Effectiveness
- Efficiency
- Productivity
- Performance
- Success
- Failure

The search will be done using the following search string:

(Scrum OR Kanban OR Waterfall OR "Extreme Programming" OR DevOps)

AND

(Effectiveness OR Efficiency OR Productivity OR Performance OR Success OR Failure)

4.2.2 Exclusion Criteria

The systematic review will include articles meeting the following criteria:

- Published after January 1, 2020
- Published in English
- Relevant to the research question
- Empirical evidence
- Quantitative studies
- One of the 20 first results from each database
- Evaluating the effectiveness of the following methodologies:
 - Scrum
 - Kanban
 - Waterfall
 - Extreme Programming
 - DevOps

4.2.3 Result

After applying the exclusion criteria to a set of 60 articles, we discovered that 4 of them were duplicates. The 56 remaining articles were screened by title and abstract, resulting in 12 articles being excluded. The 44 remaining articles were assessed for eligibility, resulting in 33 articles being excluded. The 11 remaining articles were included in the review.

4.2.3.1 PRISMA flow diagram

Figure 1 shows the PRISMA [28] flow diagram for the scoping review. The PRISMA flow diagram is a standardized way of reporting the results of a scoping review.

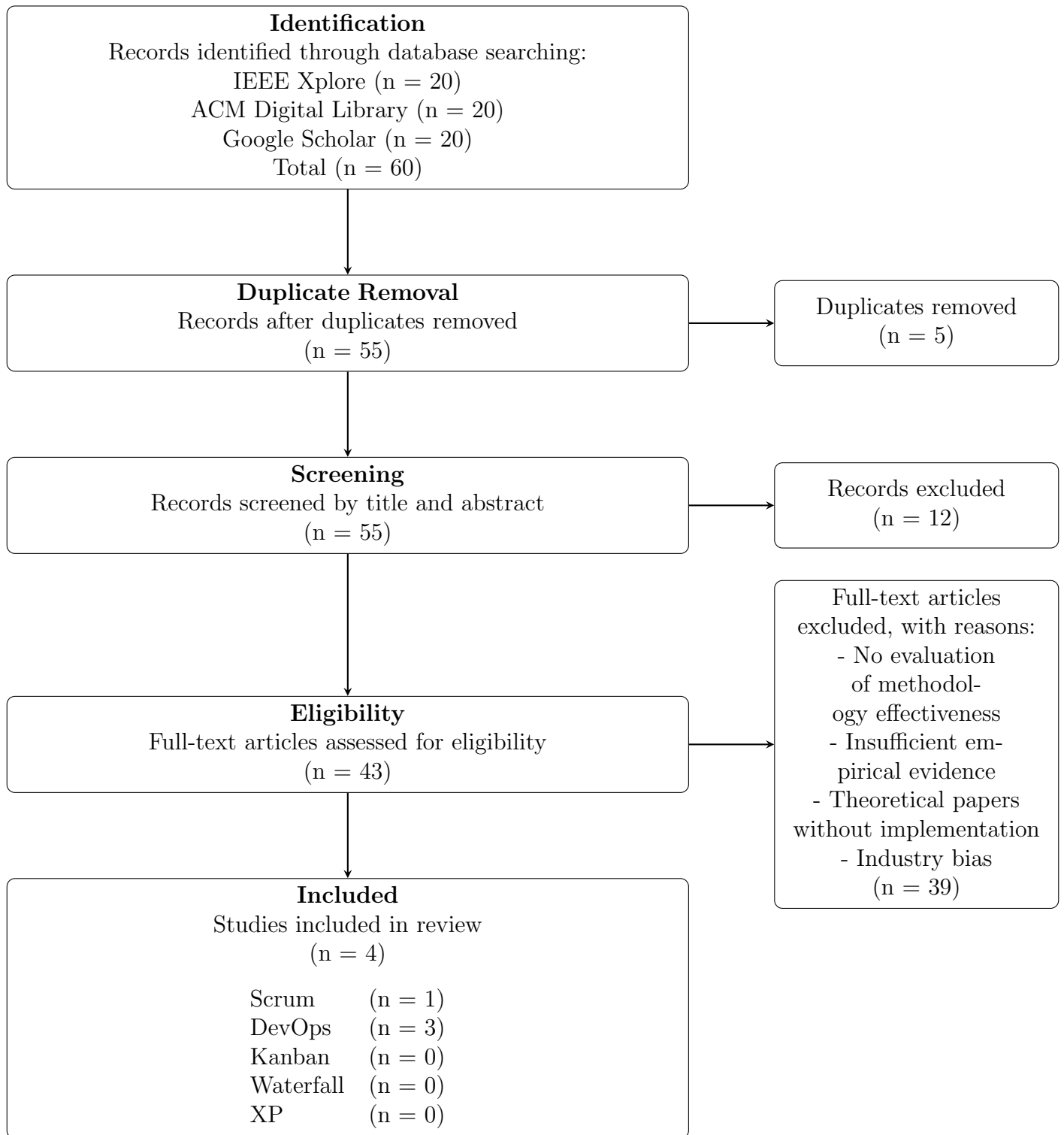


Figure 1: PRISMA flow diagram for scoping review of software development methodologies

4.3 Scrum

Scrum is a framework for agile software development. The term Scrum is derived from the game of rugby, where a scrum is a way of restarting play after a minor infringement [29]. The use of the term Scrum in software development was first introduced by Takeuchi and Nonaka in 1986 in a paper titled "The New New Product Development Game" [31]. In the paper, the authors argue for a new approach to product development where the different stages of development are overlapped, rather than sequentially executed in a "pass the baton" fashion. This differs from the then popular NASA type PPP (Phased Project Planning) model [27].

Modern Scrum development consists of a set of sprints, these sprints consists of a pre-defined set of tasks that are to be completed in the pre-defined sprint time frame. Each task or "story" is assigned an arbitrary number of points that represents the complexity of the task. The sprint is the completed when there a no more points to be completed or the time frame is up. There are many modern flavors of Scrum, like Accenture's [2] Autoscrum which is a scrum framework that was first introduced in the talk "AGILE TRANSFORMATION? FOR COMPLEX SYSTEMS? ...NO WAY!" by Brehm [7] as can be seen in *Figure 2*. Or the scaled agile framework (SAFe) [13] which is a framework developed by Scaled Agile Incorporated which introduces SAFe Scrum see *Figure 3*. Or the Deloitte's [9] "The Agile Landscape v3" that consists of all the different frameworks and methods used for project management. See the Scrum section in *Figure 4*.

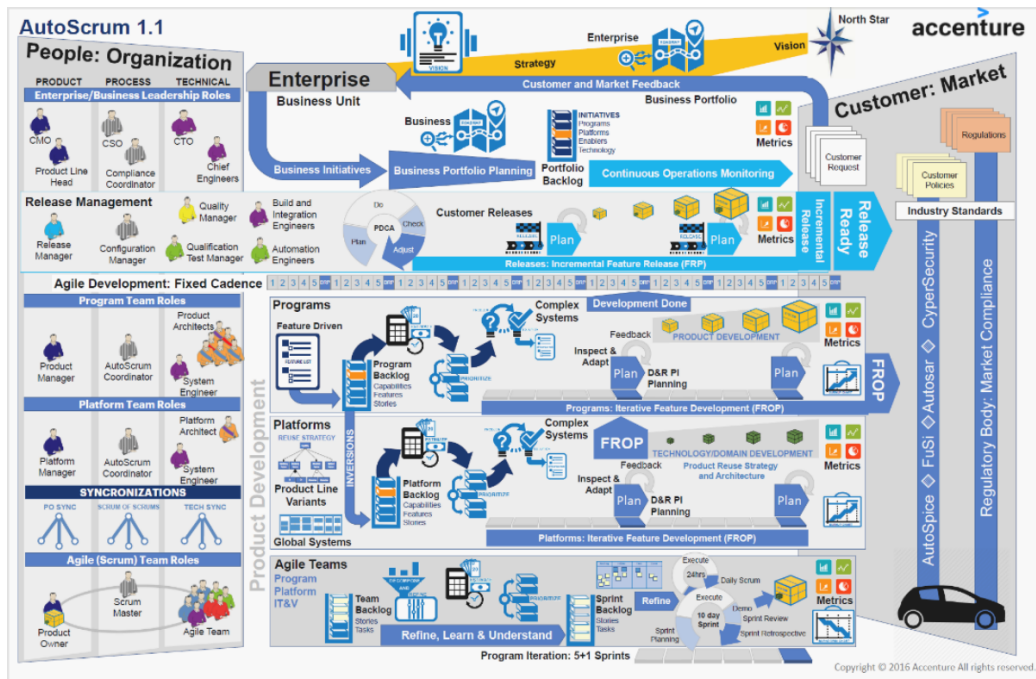


Figure 2: Excerpt from the presentation "AGILE TRANSFORMATION? FOR COMPLEX SYSTEMS? ...NO WAY!" by Brehm [7] showing the Autoscrum framework.

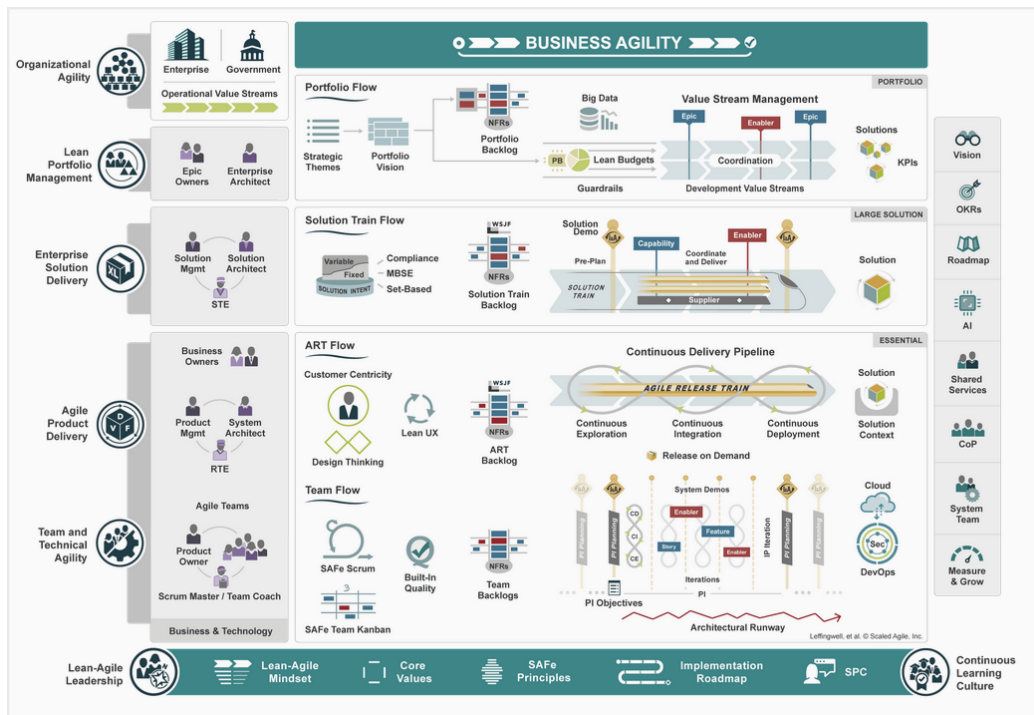


Figure 3: The Scaled Agile Framework (SAFe) [13].

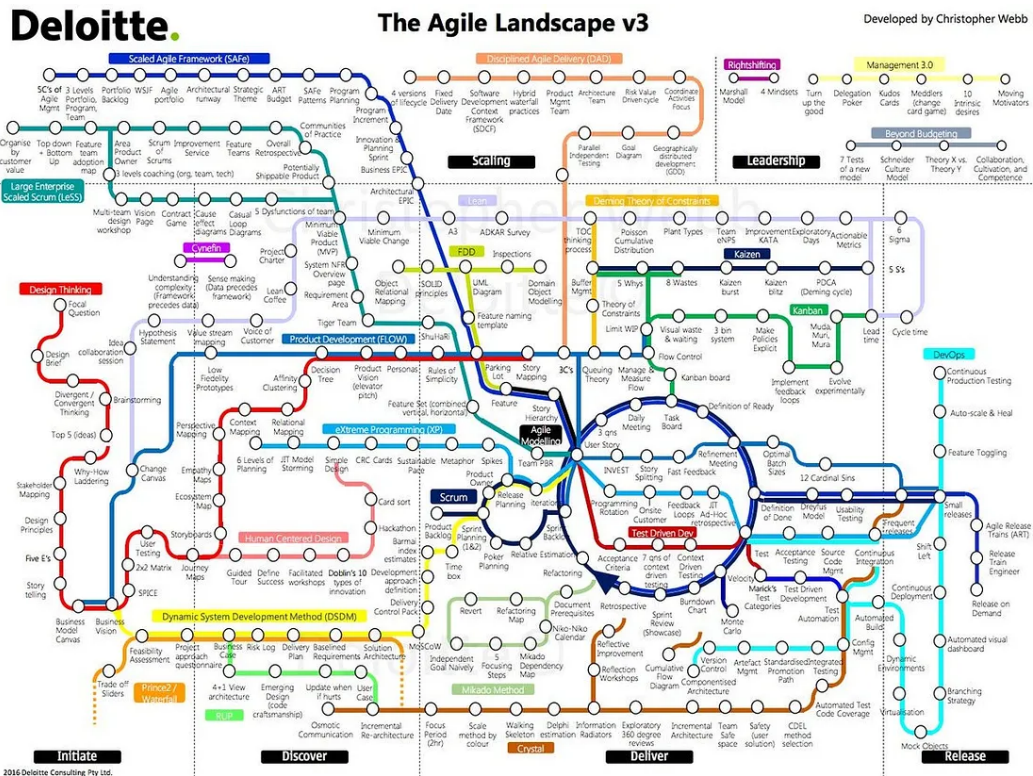


Figure 4: The Agile Landscape v3 [9] showing the different frameworks and methods used for project management.

4.3.1 Evidentiary foundation

With only one article "A Theory of Scrum Team Effectiveness" by Verwijs and Russo [32] we can conclude that there is no empirical evidence that Scrum increases worker productivity or efficiency. Whilst the findings of the article seems promising, there simply is not enough research on the topic to comment on the evidentiary foundation of Scrum, this is something taken in too account by the authors of the article. Only a handful of other articles have been published on the topic, but most of them fall outside the exclusion criteria of the scoping review as they have been published before 2020.

4.4 Kanban

Kanban is a framework for agile software development. The term Kanban is derived from the Japanese word for "signboard" or "billboard" [19]. A Kanban board is a visual representation of the tasks that need to be completed, the board consists of multiple columns that represent the different stages of the development process. As a task is worked on it traverses the columns of the board until it is completed. This provides a visual representation of the state of the project and allows for easy identification of bottlenecks in the process. Kanban is a much more flexible and lean approach to project management than Scrum, as it follows closer to the agile manifesto's principles of flexibility and adaptability [22].

4.4.1 Evidentiary foundation

With no articles found in the scoping review we can conclude that there is no empirical evidence that Kanban increases worker productivity or efficiency.

4.5 Waterfall

The waterfall [33] is a linear and sequential approach to software development. Sets of tasks are grouped into phases, where each phase must be completed before the next phase can begin. This is reminiscent of the NASA type PPP (Phased Project Planning) model [27]. The waterfall model mirrors the traditional problem solving process, of breaking a problem down into a set of smaller problems, and solving each of the smaller problems in a sequential manner. This is something that is found at the core of all project management methodologies.

4.5.1 Evidentiary foundation

With no articles found in the scoping review we can conclude that there is no empirical evidence that Waterfall increases worker productivity or efficiency.

4.6 Extreme Programming

Extreme Programming [12] is a framework for agile software development. Extreme Programming takes the best practices of software development and takes them to the extreme, hence the name. A core part of Extreme Programming is the use of pair programming [26], where two developers work together on the same code.

4.7 Evidentiary foundation

With no articles found in the scoping review we can conclude that there is no empirical evidence that Extreme Programming increases worker productivity or efficiency.

4.8 DevOps

DevOps is the combination of development and operations, it is the practice of combining software development and IT operations. This keeps the developers close to the day to day operations of the software they are developing. A result of developer operations is the use of automated continuous integration and continuous deployment (CI/CD) [8] systems as the responsibility of the deployment falls on the developers. This methodology fosters early error detection and correction.

4.8.1 Evidentiary foundation

DevOps and Research Assessment (DORA) [10] is a research department at Google that focuses on researching assessment methods for DevOps. They publish a yearly report on the state of DevOps. Other than DORA independent research into the topic is scarce and whilst research is being done there is currently not a strong enough evidentiary foundation to make any claims about the effectiveness of DevOps.

4.9 Conclusion

The scoping review has made it clear that there is a lack of research into the effectiveness of different work methodologies. The industry seems focused on researching performance metrics for each methodology, rather than the effectiveness of the methodology itself.

5 NETCONF and YANG sensor management

Hardware management is an essential part of administrating a larger network. Together with Lightside Instruments we have developed open source tools for YANG and NETCONF aimed at hardware sensor management.

5.1 YANG Model

The YANG model is a model used to describe the state and actions of a NETCONF device. The Internet Engineering Task Force (IETF) has developed a set of standard YANG models for NETCONF devices. For the purposes of this project we will not be using the standard YANG models, but instead we will be using a custom YANG model developed by Lightside Instruments AS that only describes the state of thermometers. See *Figure 5* for the YANG model.


```

module lsi-thermometers {
  yang-version 1.1;
  namespace "urn:lsi:params:xml:ns:yang:thermometers";
  prefix thermometers;

  organization "Lightside Instruments AS";

  description
    "Thermometers monitoring module.";

  revision 2022-07-25 {
    description
      "Initial version.";
  }

  container thermometers {
    config false;
    list thermometer {
      key "name";
      leaf name {
        type string;
      }
      leaf value {
        description
          "Temperature in degrees Celsius multiplied by 100.";
        type int32 {
          range "-27315..max";
        }
      }
    }
  }
}

```

Figure 5: YANG model for thermometer management

5.2 Node-RED

Node-RED is a low code programming tool for event driven applications. It makes it possible to create arbitrary flows that function as a compatibility layer between different systems and protocols. The low code nature of Node-RED makes arbitrary system integration accessible even for the lay person.

5.2.1 Red-Netconf

Red-Netconf [1] is a Node-RED plugin that implements the following two nodes:

- **Netconf Session:** This node is used to create a NETCONF session with a NETCONF device.
- **Netconf Yangcli:** This node is used to send NETCONF commands to a NETCONF device using yangcli commands.

Using these two nodes we are able to create Node-RED flows that can manage NETCONF devices.

5.2.1.1 Temperature alert

As an example of how the Red-Netconf nodes can be used we created a Node-RED reference flow that collects data from a thermometer and switches on an LED when the temperature is above 25 degrees Celsius, this can be seen in *Figure 6*.

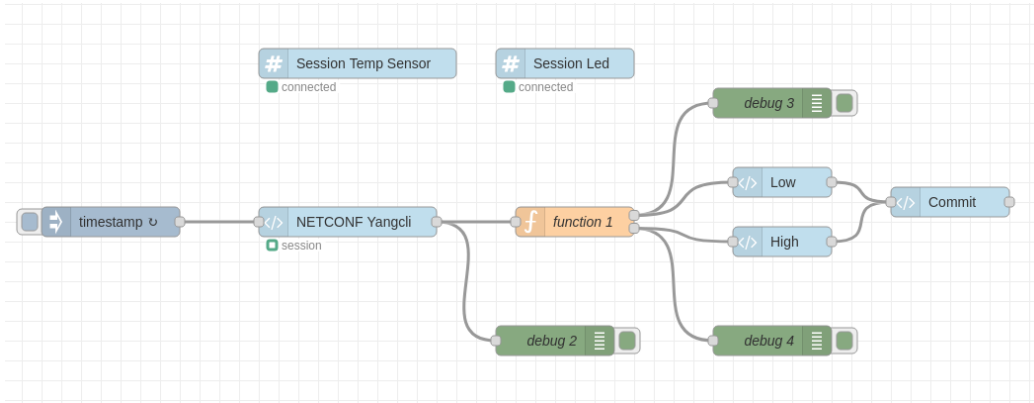


Figure 6: Node-RED flow using Red-Netconf nodes that monitors a temperature sensor and switches on an LED when the temperature is above 25 degrees Celsius.

5.2.2 Node-Yuma123

Node-Yuma123 [23] is a NodeJS package that implements a set of Yuma123 bindings.

5.2.2.1 easyNetconf

5.3 Grafana

6 NETCONF Security

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