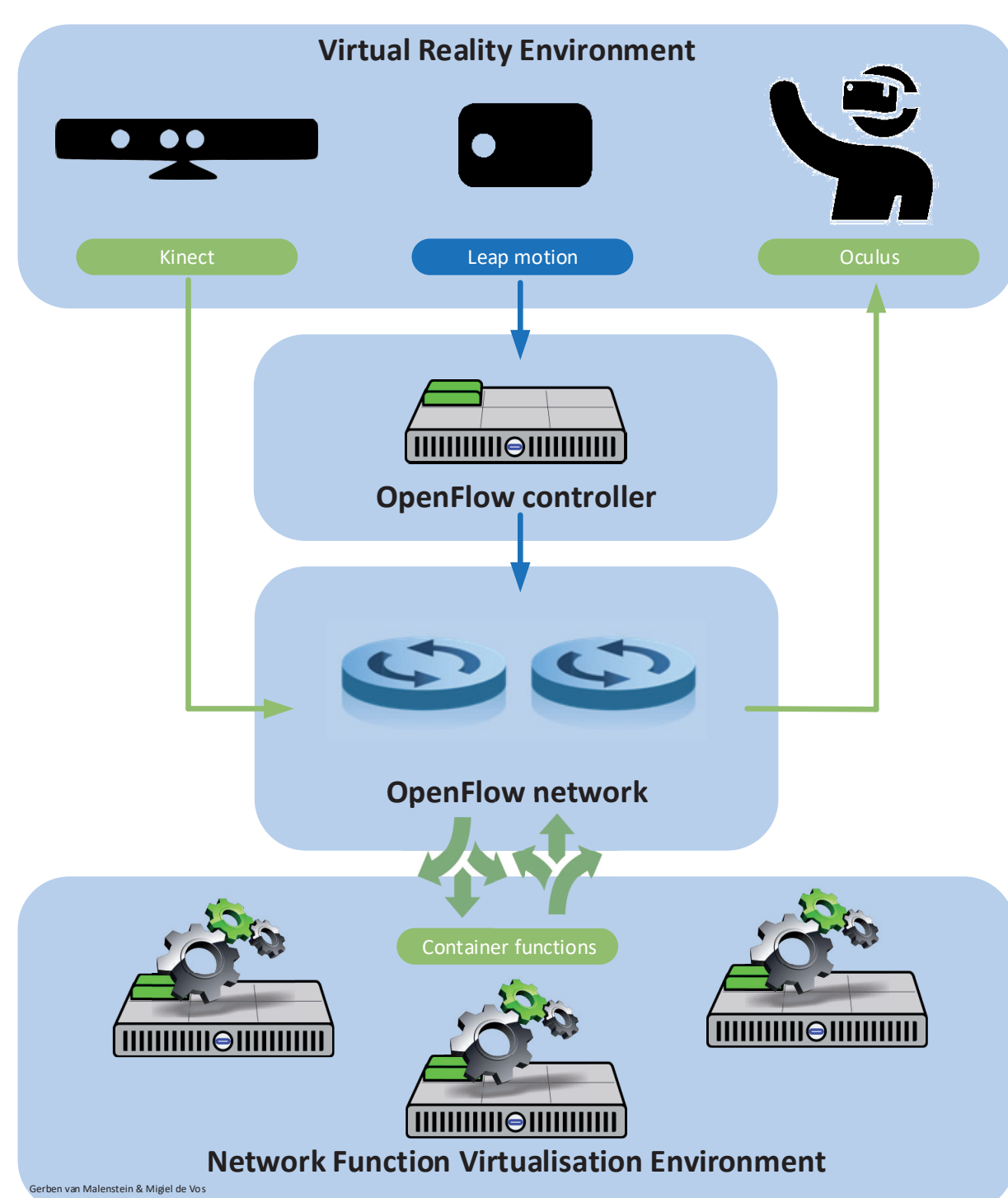


REAL-TIME VIRTUAL REALITY SERVICE FUNCTION CHAINING USING NETWORK FUNCTION VIRTUALISATION AND THE NETWORK SERVICE HEADER

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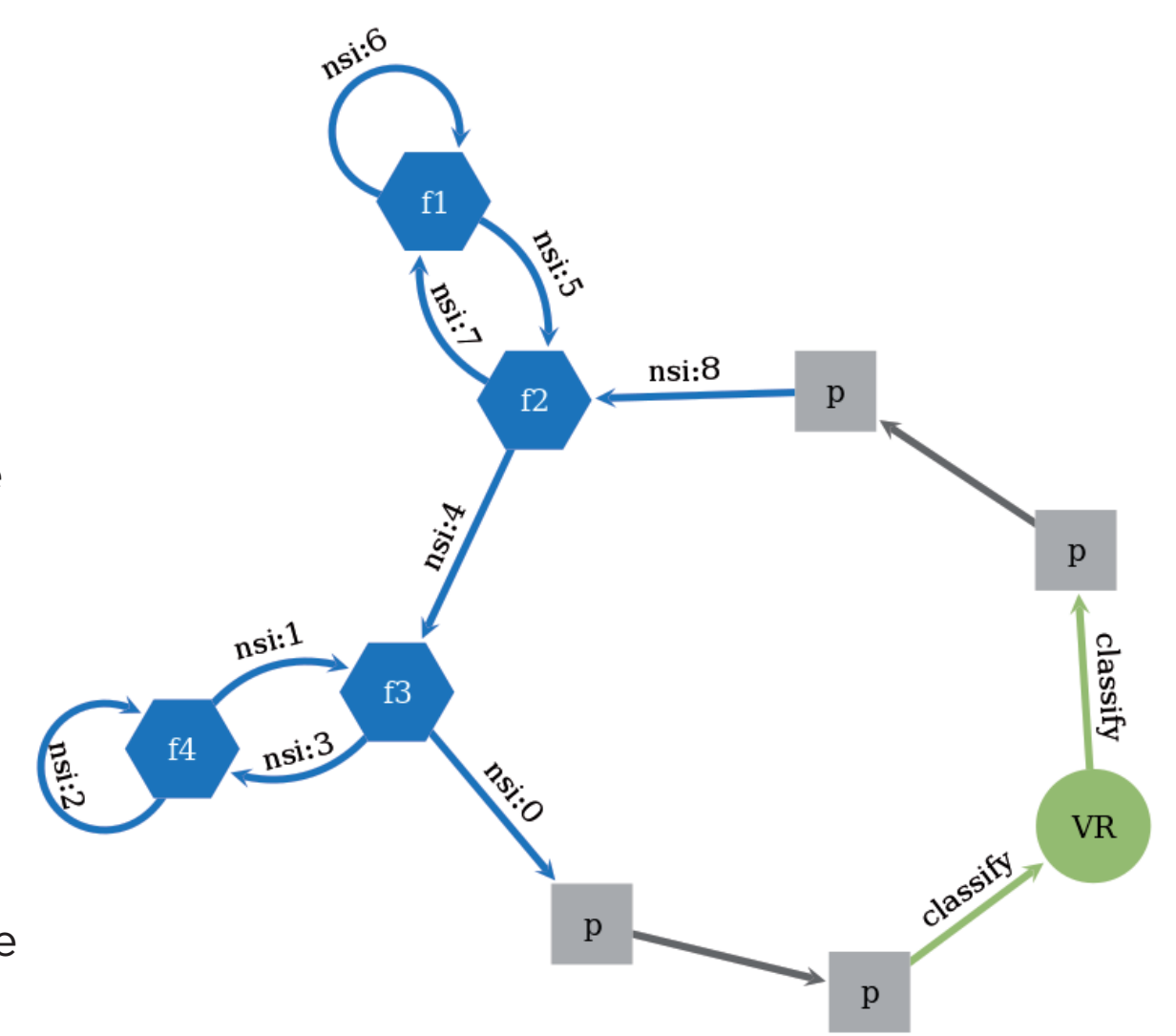
OVERVIEW

During this demonstration we are showing real-time transformations on a 3D mesh, initiated from the depth data of a Kinect sensor pointed towards the user in the SURF booth at SuperComputing 2016 in Salt Lake City, Utah. In our setup the user experiences real-time texture transformations when applying various functions. This data is manipulated real-time, applying various effects requested by the user. Network functions are controlled by a LeapMotion sensor the user is wearing. Under the hood we're using the Network Service Header (NSH) to pass traffic through the Network Functions.



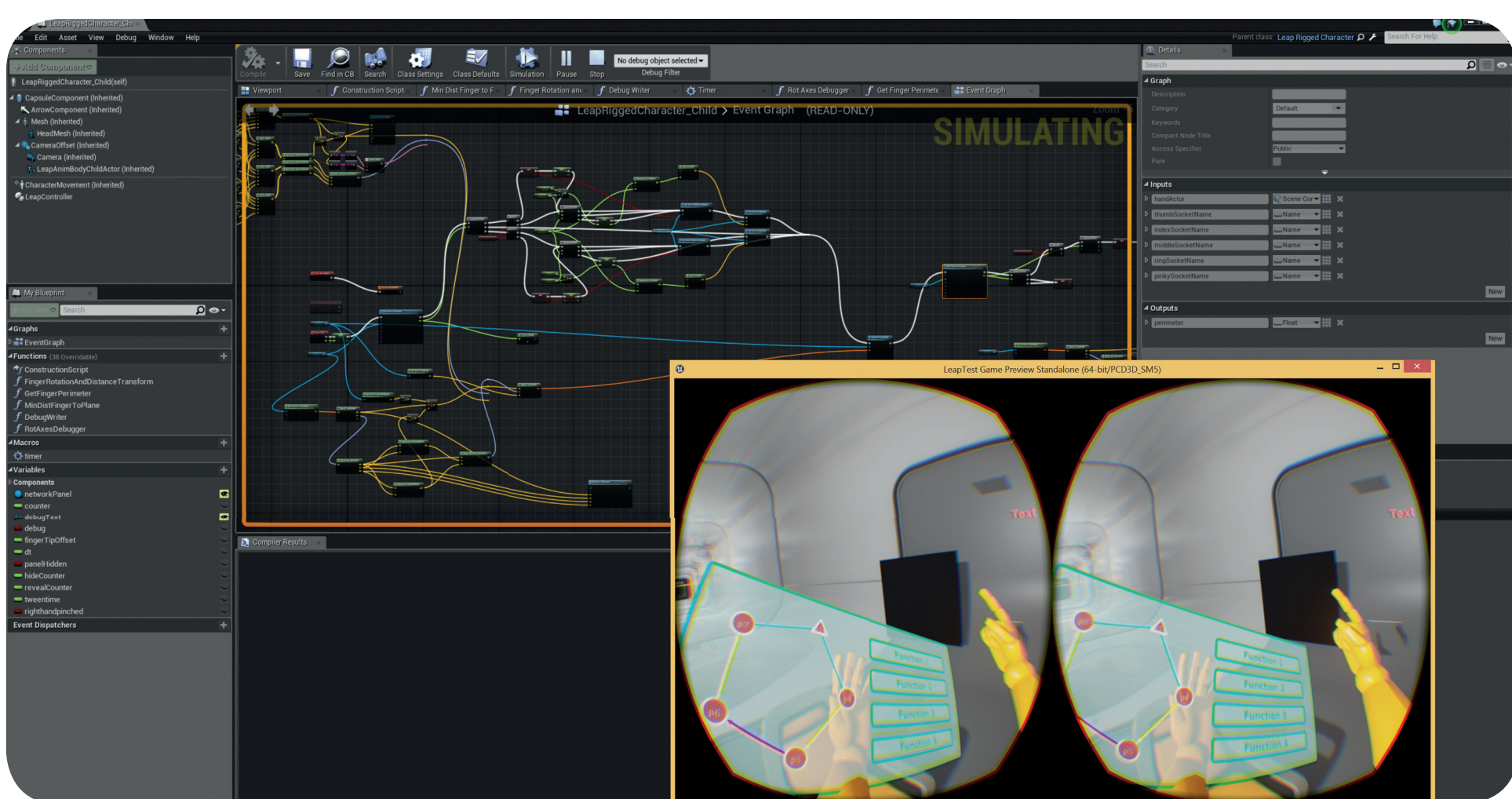
CHAINED NETWORK FUNCTIONS IN DOCKER CONTAINERS

All Network Functions in this demonstration perform their unique real-time manipulations on the depth data received from the Kinect sensor. All Network Functions reside within their own Docker container and are fully Network Service Header (NSH) aware. The Network Service Header is invisible to the end user, so traffic is transparently transported through our setup. Data can be forwarded through multiple service function paths, effectively creating a chain. In a production network, Network Functions could be rate limiting, firewalling, intrusion detection, et cetera.



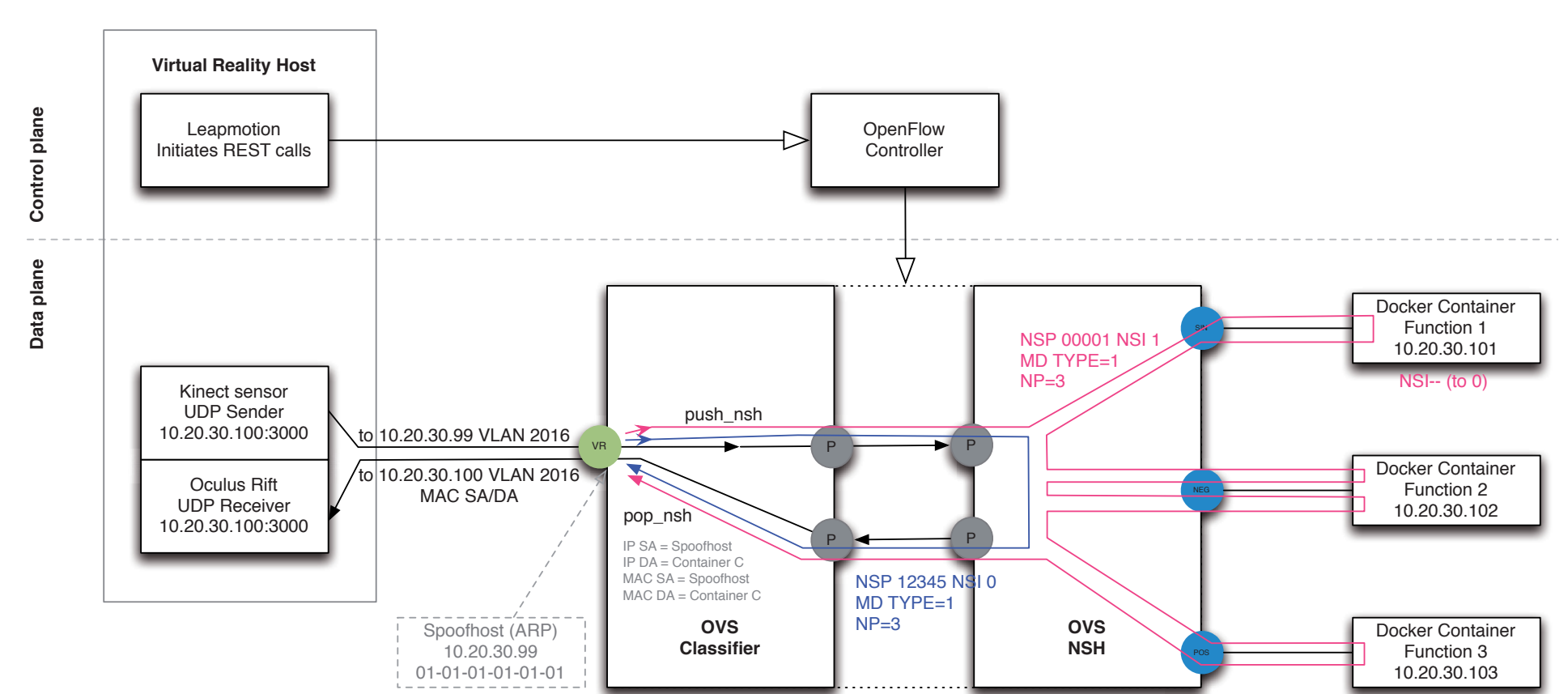
VIRTUAL REALITY IMPLEMENTATION

The VR host's demo application acquires depth data of the visitors at the SURF booth with a Microsoft Kinect 2.0. This Kinect depth data is streamed to the on-site NFV-capable equipment that performs several transformations on the depth data. The depth data is then received back at the VR demo application, which constructs a 3D mesh of the manipulated depth data. The user can choose how the depth data is manipulated by choosing between several transformations with the Network Function Control GUI driven by the LeapMotion. All of this functionality resides in one single application developed in the Unreal Engine 4, well capable of handling all the different processes needed to realize a fully immersive demo in VR with the Oculus Rift DK2.



NETWORK SETUP

At our SC'16 booth in Salt Lake City, Utah, we are having a local platform to work with the Network Service Header (NSH) and to perform Network Function Virtualisation (NFV). The depth data from the Kinect sensor is sent to this platform in an UDP stream. All UDP traffic arriving at an Open vSwitch (OVS) instance is classified by pushing the Network Service Header onto it. By using the NSH the UDP stream follows a so-called Network Service Path (NSP) - inside multiple OVS instances that are NSH aware - and has a Network Service Index (NSI) to locate its current hop. The Network Functions are fully NSH-aware and are able to modify the NSH protocol field headers. The NSI is decreased by 1 inside every network function and will finally reach 0, when all functions have been performed. At this stage, the network removes the NSH by de-classifying the traffic and sends it back to the UDP receiver as if it would have been the original UDP stream.



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