

4

GACHA NOKIA KARAMALMI PILOT



PILOT INFORMATION

- Public pilot in **mixed traffic**
- Pilot length **2 weeks**
from 10th to 12th September and
from 1st to 3rd October
- Operational from Tuesday to Thursday
from 10 am to 2 pm





NUMBERS

- Total **6 days** of operation
- Bus speed was limited to 5 m/s (18 km/h); increase of 1m/s compared to Otaniemi pilot
- **146 km** → avg 24 km / day → Same as in Otaniemi
(half of the Karamalmi pilot with lowered battery capacity)
- **217 passengers** → avg 36 passengers / day
(in Otaniemi 20 passengers / day)

NOKIA RADIOACTIVE DAYS

- Total **5 demos in 3 days** (not included in pilot calculations)
- Nokia had a **Facebook live** for 13 million followers about 5G inside the bus



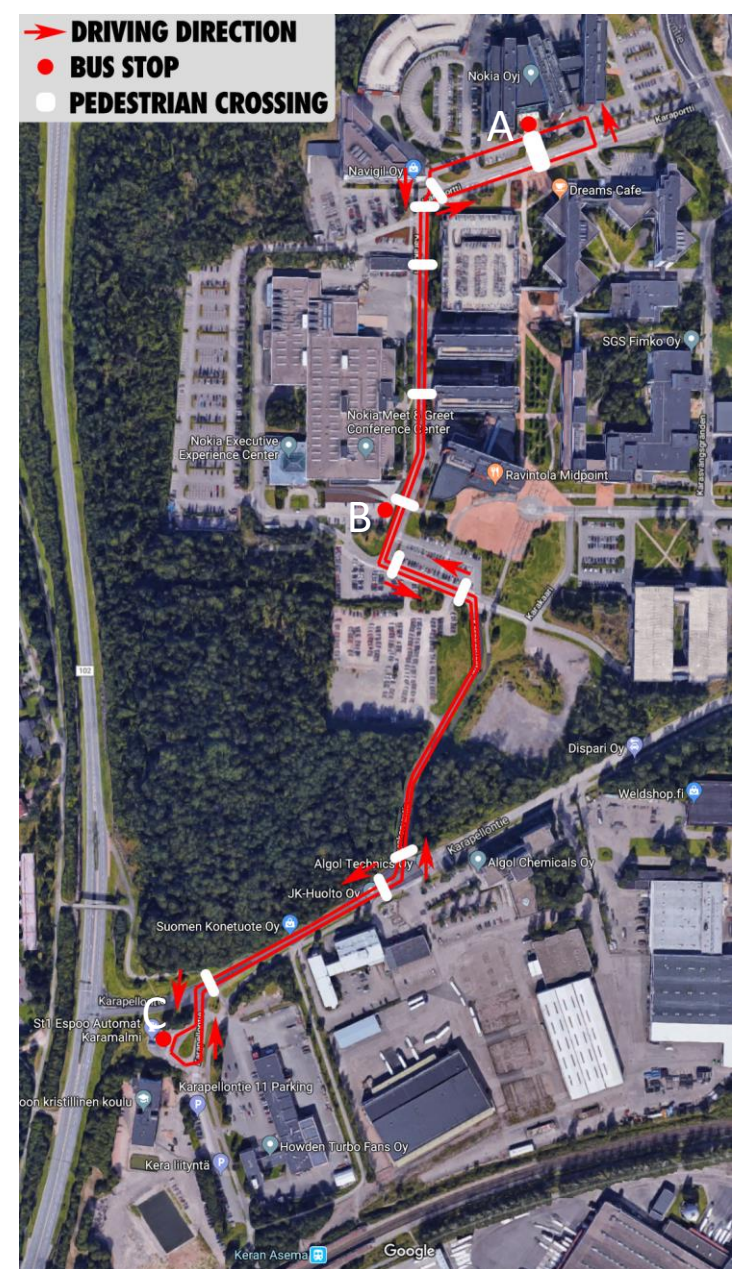


SURVEY ANSWERS

- 12 answers in total. All in Finnish
- GACHA felt...
 - **Very safe 67%** (8 answers)
 - Quite **safe 33%** (4 answers)
- Bus speed was...
 - **Ok 58%** (7 answers)
 - Too slow 42% (5 answers)
- Some comments:
 - Quite exciting experience. Entertaining
 - Seat belts (in question "what features you would like to see in the bus?")
 - Very comfortable experience
 - It worked otherwise ok, but some turns and some braking was a bit rough
 - It would be nice to have bus running from railway station when you are going to work and back when leaving from work

KERA – NOKIA ROUTE ANALYSIS FOR GACHA PILOT (SEPTEMBER 2019)

- Route from Kera railway station to Nokia Campus area. Mixed traffic
- Maximum speed of the bus limited to 5 m/s (=18 km/h)
- Two safety operators inside. First person (in front) with joystick has possibility to intervene at any time and second person (in back) observes bus sensor visualization
- One lane roads except for intersection areas, where might be short sections of two lanes
- Total route length ~2,2 km. With normal operation speed complete route duration ~15 min
- Pilot hours 10 am – 2 pm
- Normal Finnish autumn weather. Temperatures usually from +5° to +10°. Possibility for rain and mist
- Driving direction counterclockwise
- 3 bus stops (A, B, C)
- 7 left turns
- 5 right turns
- 11 individual pedestrian crossings, total 22 times crossed
- No reports available of traffic volume in Nokia campus area. Typically quiet area with only cars visiting Nokia buildings during pilot hours.
- Karapellontie has some traffic from Kehä 2 / Kilonväylä (which typically had 14,275 vehicles / day in 2018).



SELF-DRIVING **EVERYWHERE**

GENERAL ACTIONS IN RISKY SITUATIONS

- Other vehicles speeding or breaking laws
 - Obstacle detection
 - Increased safety operator attention
 - Involve police if needed
- Other vehicles overtaking the vehicle and returning too close in front
 - Obstacle detection slowing down
- Leaving from bus stop
 - Informing other around the bus with lightbelt "Leaving" text and using blinkers
 - Increased safety operator attention
- Narrow lanes
 - Lowering speed in trajectory
 - Possible manual obstacle avoidance
- Pedestrian crossings
 - Lowering speed in trajectory
 - Obstacle detection
- Low visibility
 - Ask for city to improve visibility (vegetation trimming)
 - Lowering speed in trajectory
 - Obstacle detection
- Obstacle in the way
 - Obstacle detection stopping the vehicle
 - Manual obstacle avoidance

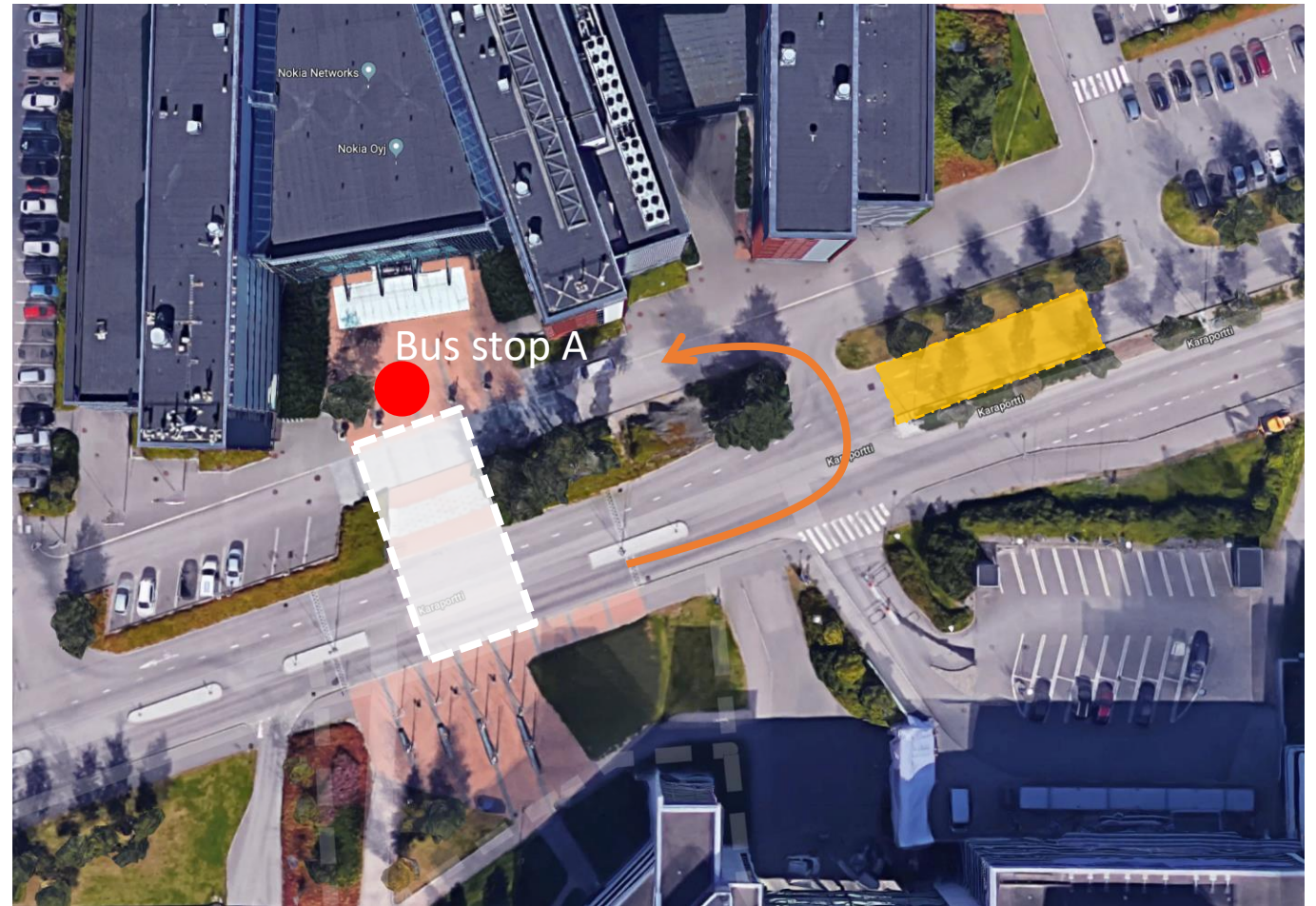


LEGEND

• Driving direction	
• Bus stop	
• Pedestrian crossing	
• Hazardous traffic	

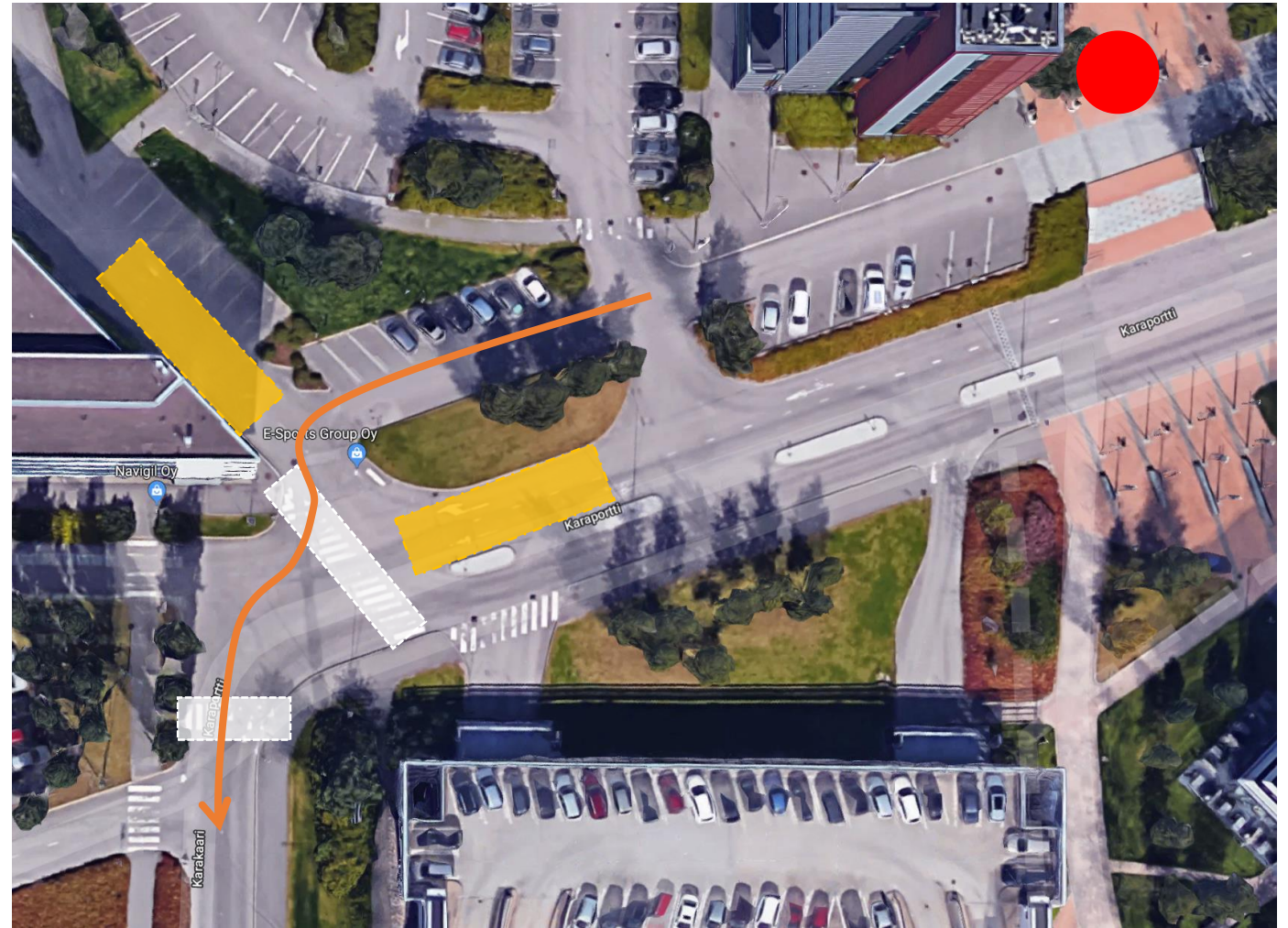
ENTERING KARAPORTTI 3 AREA

- Potential hazardous zone entering Karaportti 3 bus stop (A). Quite a lot of pedestrians and some oncoming vehicles
- Turning **left** from Karaportti to the bus stop. Pedestrian crossing. Bus needs to yield oncoming vehicles. Bad visibility because of the trees in the middle of the road. Actions:
 - Pedestrian crossing features to semantic map for obstacle detection
 - Intersection features to semantic map for obstacle detection
 - Increased safety operator attention



EXITING FROM KARAPORTTI BUS STOP TO KARAKAARI

- Potential hazardous zone exiting Karaportti 3 bus stop and entering to Karakaari. Pedestrian crossing and parked vehicles
- Turning **left** from from the bus stop to Karaportti and then to Karakaari. Pedestrian crossings. Bus needs to yield vehicles coming from parking lot from right and vehicles driving Karaportti. Actions:
 - Pedestrian crossing features to semantic map for obstacle detection
 - Intersection features to semantic map for obstacle detection
 - Increased safety operator attention



BUS STOP B NOKIA MEET & GREET

- Potential hazardous zone entering and exiting Nokia meet & greet bus stop (B). Pedestrian crossings. Entering back to the road
- Just before entering Nokia meet & greet there is pedestrian crossing. Bus will turn **left** to the road when exiting the bus stop. Turning **left** second time. Bus needs to yield vehicles coming from right. Second pedestrian crossing. Actions:
 - Pedestrian crossing features to semantic map for obstacle detection
 - Intersection features to semantic map for obstacle detection
 - Increased safety operator attention
 - Informing other road users with lightbelt and blinkers



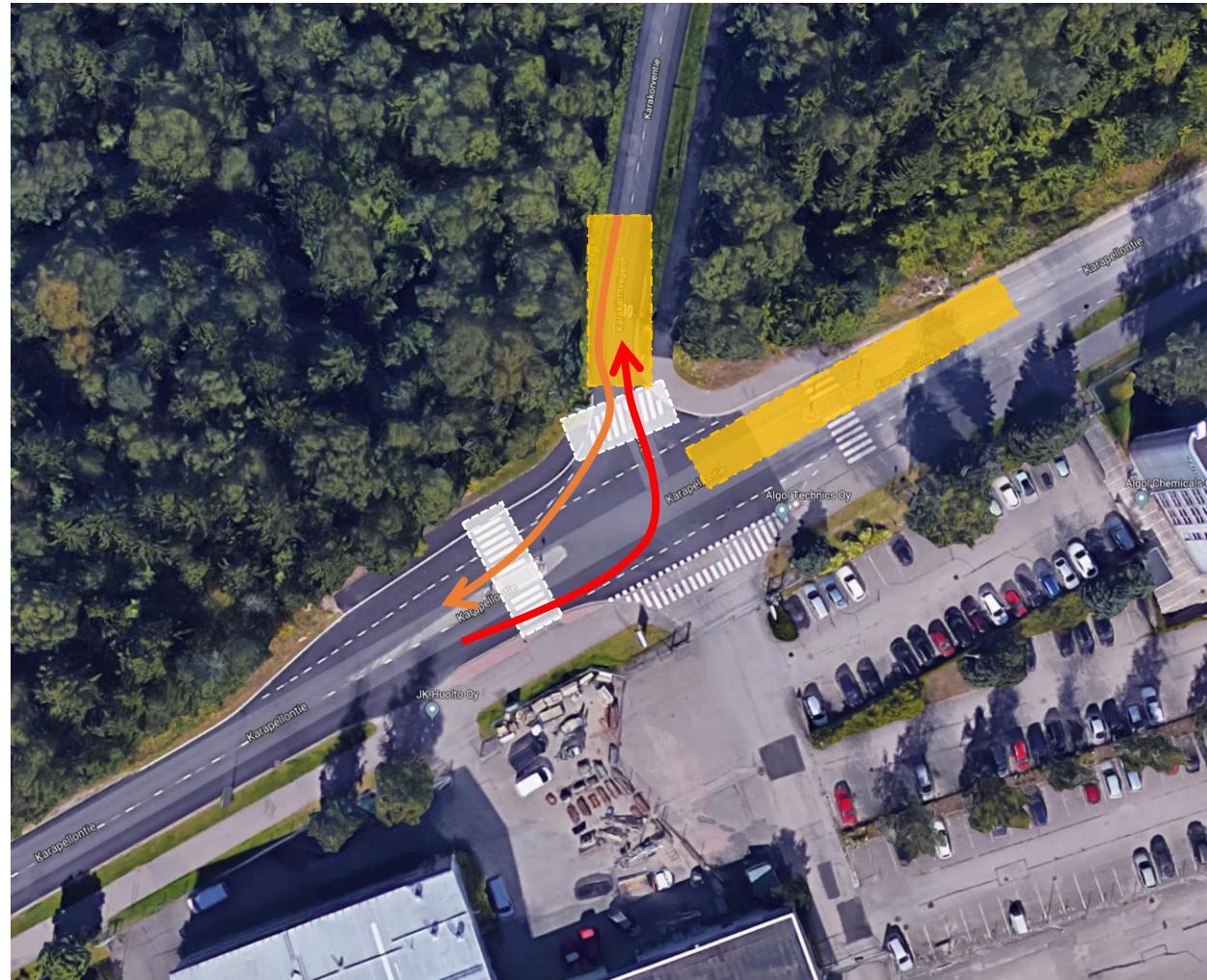
KARAKORVENTIE / KARAKAARI INTERSECTION

- Potential hazardous zone turning left from Karakorventie. Pedestrian crossing
- Turning **left** from Karakorventie to Karakaari. Vehicle needs to yield vehicles coming from right. Actions:
 - Pedestrian crossing features to semantic map for obstacle detection
 - Intersection features to semantic map for obstacle detection
 - Increased safety operator attention



KARAPELLONTIE / KARAKORVENTIE INTERSECTION

- Potential hazardous zone around Karapellontie / Karakorventie intersection. Quite high volume of high speed vehicles. Low visibility and narrow lanes when coming from Karakorventie.
- Turning **right** from Karakorventie. Two pedestrian crossings, low visibility to left and bus needs to yield high speed vehicles coming from left. Narrow lanes. Actions:
 - Pedestrian crossing features to semantic map for obstacle detection
 - Intersection features to semantic map for obstacle detection
 - Increased safety operator attention, especially if vehicles are turning from Karapellontie to Karakorventie. Possible manual obstacle avoidance, narrow lane
- Turning **left** from Karakorventie. Two pedestrian crossings and vehicle needs to yield high speed oncoming vehicles. Narrow lanes. Actions:
 - Pedestrian crossing features to semantic map for obstacle detection
 - Intersection features to semantic map for obstacle detection
 - Increased safety operator attention, especially if vehicles are waiting at Karakorventie. Possible manual obstacle avoidance, narrow lane



KARAPELLONTIE INTERSECTION

- Potential hazardous zone around Kera station bus stop (C). Quite high volume of high speed vehicles.
- Turning **left** from Karapellontie to the bus stop. Pedestrian crossing. High speed vehicles coming from Kilonvöylä. Vehicle needs to yield oncoming vehicles. Actions:
 - Pedestrian crossing features to semantic map for obstacle detection
 - Intersection features to semantic map for obstacle detection
 - Increased safety operator attention
- Turning **left** from the bus stop to Karapellontie. Vehicles driving to and from the railway station. Bus needs to yield vehicles coming from both left and right. Actions:
 - Intersection features to semantic map for obstacle detection
 - Increased safety operator attention
- Turning **right** from Karapellontie to Karapellontie. Bus needs to yield vehicles coming from left. Pedestrian crossing. Actions:
 - Intersection features to semantic map for obstacle detection
 - Pedestrian crossing features to semantic map for obstacle detection
 - Increased safety operator attention



CONCLUSION

Most potential risks

- Karapellontie / Karakorventie intersection
 - Turning right from Karakorventie. Low visibility for vehicles coming from left. Current autonomous system cannot react on time for some of the vehicles coming from this direction
 - Severity class: 4
 - Probability: 2
 - Risk score: 8
 - How to improve: Enable tracking for obstacles from further distance, cut/trim the bushes and trees in the intersection
 - Current action: Increased safety operator attention
- Entering Karaportti 3 bus stop
 - Turning left from Karaportti. Low visibility for oncoming vehicles. Current autonomous system cannot react vehicles coming behind vegetation in time
 - Severity class: 3
 - Probability: 2
 - Risk score: 6
 - How to improve: Enable tracking for obstacles from further distance
 - Current action: Increased safety operator attention

Severity and **Probability** scale: 1-5 (1 being lowest and 5 highest)

Risk score = Sev x Prob. Scale: 1-25 (values scoring 5-9 must be evaluated with corrective actions & suggestion for improvement, values above 10 need corrective actions & improvements made before starting operations)

PLANS FOR CONTINUOUS OPERATION

- Continuous operation is a natural follow-up for the pilot
- Sensible 4 and Nobina are preparing a proposal for continuous operation in Karamalmi area:
 - Start around change of 2020-21
 - Duration 1+1 years
 - Min. two autonomous busses
- Target is "real" operation
 - Bus operator (Nobina) takes care of everyday operation and maintenance
 - Busses are supervised from Nobina's control center
 - System provider (Sensible 4) supplies the bus and maintenance & updates of the automation system

