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JOURNAL

PROJECT

LINC - Transforming Urban Planning Providing Autonomous Collective mobility

Albertslund, Denmark

TOPIC

Urban mobility

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LINC project Journal 4 - get an update about the Albertslund project

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In Journal 4 we analyze the progress towards getting the self-driving buses ready to run in the LINC project. In particular, we explore challenges encountered by the project.

Executive Summary

This journal is authored by Dr. Anna Pernestål, UIA Expert for the LINC project.

This fourth UIA journal describes the progress of the LINC during 2020 and winter 2021. It has a special focus on the preparations for the tests with self-driving shuttles on public streets and on the impacts of Covid-19 on the project work. The journal also discusses the main challenges in the project, and how the team has approached them.

One main focus of the project has been to obtain legal permission to operate self-driving shuttles on public streets. The application process has been long and included various assessments and tests, writing of documentation, submission of complementary information to the approving authority, and long waiting times. The process has been much longer and more challenging than anyone could expect, and led to significant delays in the project. Finally, the approval to start the tests was obtained in April 2021, nearly one year after the application was sent in.

In parallel with the legal approval, the project has developed a smartphone sensing platform for data collection for operation and evaluation. Furthermore, simulation studies are set up, so that the data collected in the project can be used to analyze the up-scaling impact of the mobility service.

The Covid-19 pandemic has hindered the project in several ways. The lockdowns significantly reduce the transport needs of people in general and potential users at DTU Campus in particular. The project has adapted to that fact by replanning the tests. The lockdowns have also made the collaborative work in the project challenging.

Currently, the hardest challenges in the project are “Leadership for innovation” and “Communication with target beneficiaries”. At the core of these challenges are the delayed tests, and the fact that the project had not yet been able to collect evidence for the opportunities with the self-driving shuttle service. The project is working hard to

approach these challenges with workshops, and simulation studies. Also, the tests that could finally start in April 2021 will be important to increase leadership for innovation and in communication with target beneficiaries.

Project progress

The rubber can hit the asphalt!

The Danish legislative process for approval to operate self-driving vehicles on public streets is one of the most restrictive in the EU, and includes many parallel approval steps involving the Danish Transport Authority, The Danish Road Directorate, and a third party safety assessor. In the LINC project the application, including evaluations from the third party assessor, was sent to the Danish Road Directorate in June 2020. Several additional questions from the authorities had to be answered, and the official processing of the application could not start until November 2020.

After the authority's review of the application, a four weeks long public hearing period, and a processing period, the Danish minister of transport declared the test with self-driving shuttles on DTU Lyngby Campus approved on March 18th, 2021. This was the starting point of an intense period for the LINC, including education of test drivers, mapping of the route with the vehicles, and test driving. The final approval to start operation with passengers on board at DTU Lyngby Campus was made by the assessor on April 12th.

In total, the LINC project has spent around 30 calendar months to get permission to run the self-driving shuttles on public streets on SAE level 3 (i.e. with a safety driver on-board). After a long struggle, this important milestone was achieved by the project, and on April 19th the rubber could hit the asphalt, with the passengers on board, for the first time.

The Smartphone sensing platform

The DTU Lyngby Campus test is more than self-driving shuttles. It also includes an intelligent "Smartphone sensing platform" consisting of Bluetooth beacons that sense the passengers' smartphones, an infrastructure that can combine various data sources, and a backend system for data analysis.

Valentino Servici, DTU, explains that the smartphone sensing platform can be used for multiple purposes:

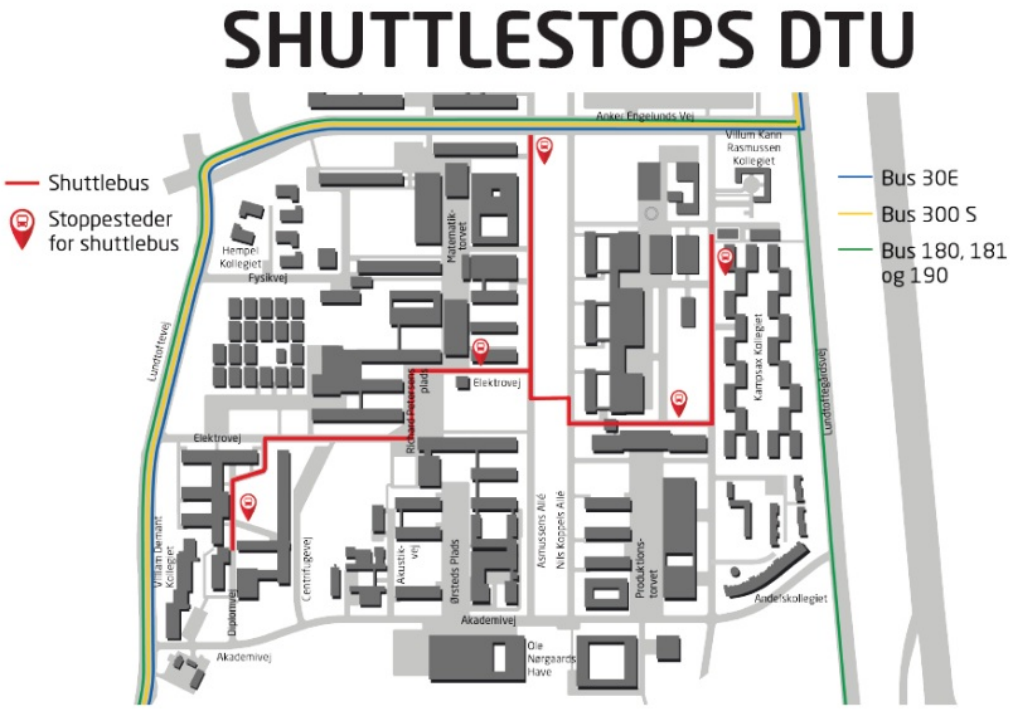
- It provides accurate positioning of passengers and recordings of anonymous movement patterns, data that can be used to tune the operation to respond to the actual demand.
- In particular, the sensing platform determines how many passengers there is onboard a vehicle. This information can then be used in the real-time operation, to determine if the vehicle can pick up more passengers.
- The platform enables smartphone data to be combined with e.g. weather forecast data and vehicle data, combinations that can be used for control of the shuttles in real-time.
- It can push information or surveys to users, triggered by events. For example, passengers that were on board during harsh braking can be asked about their experience of that directly after the event.
- The platform has a dashboard for operators, which shows real-time metrics, and also allows for analysis of operational data for service improvement.

The smartphone sensing platform has been developed during the last year and was tested together with the shuttles on closed roads on several field tests. The latest field tests took place on February 17th, 2021, and March 22nd, 2021.

Field test on february 17th, 2021 in snowy conditions on a closed road at Diplomvej, DTU Lyngby Campus. Credit: Kenneth Jorgensen

Finalizing the test plan

During the fall and the winter, the project members have worked intensively on updating the test design to respond to changes in the test caused by the delay of the legal approval and by Covid-19 restrictions. The fact that the legal approval process has been very long and uncertain has led to replanning, both in terms of when to run the tests, and what to include. In addition, the Covid-19 pandemic has introduced even more uncertainties due to lockdowns and limitations in people's movements. The final test design was set at the end of March 2021 and includes an operation with passengers at DTU Lyngby Campus from April 19th to July 2nd. The route for the test has been shortened and one bus stop removed due to road maintenance work at Niels Koppels Allé, the southernmost part of the route. The final route is shown in the Figure below. Unfortunately, even if the LINC project continues beyond July 2nd the tests cannot, due to further road maintenance covering most of the route network.



A map of the final test route for the test at DTU Lyngby Campus.

To prepare for the tests, around 488 test passengers have been recruited. Due to the Covid-19 pandemic, DTU Lyngby Campus has been closed for several months. Currently, the campus is expected to open up to around 20% of normal activity during the LINC test period. Therefore, emphasis in the recruitment of test passengers has been on people that actually are at the campus site, and recruitment has been done physically at the Campus.
The relatively short test time, caused by the complex legal environment, and the restrictions due to Covid-19 have shifted the focus of the tests. Instead of testing an optimized demand-responsive mobility service, the focus will be on testing robot-human interactions, developed user services (like event-triggered surveys), and collecting user data for mathematical simulation models. By using simulation models, the project seeks to use the real transport demand data collected by the smartphone sensing platform, and explore the trade-off between offering a pre-scheduled service synchronized with the light-rail and reserving capacity on the shuttles for on-demand services. In this way, also the test will provide useful information about on-demand services to decision-makers.
To achieve the results above, the project is dependent to have an approval of a request for project prolongation for three months. This will allow the project to gain more operational time and also the chance of having an AV operation at DTU Lyngby Campus in a post-Covid-19 reopening of the campus.

Understanding smart mobility as a part of urban planning

The long-term goal for the LINC project is to contribute with knowledge about how smart mobility can be a part of sustainable urban planning. To fulfill that goal the LINC project has performed several activities during the last year:

- Workshops with urban planners and decision-makers have been executed and more are planned for the future.
- Simulations to explore the potential impacts of shuttles as a complement to the new light rail in Hertsted Business park have been set up.
- The project has initiated a study together with ViaTrafik, to explore how first/last mile self-driving shuttles as a complement to the Copenhagen Light Rail can be integrated into urban plans. In particular, the two urban transition areas Hersted Industrial Site and Gladsaxe Erhvervsby will be studied. The aim of the study is to support sustainable urban planning processes. Specifically, the study will investigate the needs of new physical and digital infrastructure for this type of service.

While waiting for the start of the operation, simulations have become an important tool. Professor Jeppe Rich, DTU, explains:

> We want to look at the first/last mile service in conjunction with the light rail. The simulation will primarily be on Hertsted Industry Park and is based on origin-destination matrices that show how people move.

Professor Rich explains that, for example, their model aims to answer how many buses will be needed to meet a certain demand. They are also performing a cost-benefit analysis to explore the effects of the service on a societal level.

Changing the legislative landscape

The LINC project has identified the long legislative process to get the approval for the operation of the shuttles as one main barrier for the development of innovative mobility solutions in Denmark. Therefore, the project has done several efforts to change the legislative landscape related to new mobility in Denmark: A Letter of recommendations was sent to the Danish minister of transport, six recommendations for improving the Danish pilot scheme for automated vehicles has been identified and communicated, and a press release based on a comparison of the Swedish and Danish processes has been published. In addition, project members have been engaged in a national network for projects with self-driving shuttles. This network has provided a platform for the exchange of experiences but also formed a stronger body concerning legislative questions.

Impact of Covid-19 on the project

The global Covid-19 pandemic and the related lockdowns and restrictions have impacted the project in multiple ways.

The lockdowns of Denmark have led to that fewer people than normal will be at the DTU Lyngby Campus during the test period. This limits the number of potential users and changes the movement patterns of those that are at the campus. The pandemic restrictions have also imposed a limit of max 2 passengers on the bus, which also impacts the actual use of the busses. One project member states that

> The implication can be huge - without people walking around and taking the bus we don't have any data.

The project has replanned the tests to focus on what can be tested given the circumstances: the technology and the user's adoption of the technology, rather than the full service that originally was the plan. Furthermore, the project requested a project prolongation for an additional three months. This will give the project enough time to finalize the processing of the data from the three months testing period ending July 2nd, 2021. It could also provide opportunities for additional operational time if needed if circumstances allow (given road maintenance work, financial resources, etc).

Besides the implications for the actual tests, Covid-19 has likely also caused delays in the approval process, since Covid-19 related questions have been prioritized by authorities.

The pandemic has also slowed down the project's internal work in different ways. Important parts of the work were planned to be performed in collaboration with experts e.g. from Nobina Technology in Sweden and the vehicle supplier in France. The travel restrictions during the pandemic have put all such collaborations on hold. Furthermore, The LINC project is a truly cross-disciplinary project, where collaborative dialogues and co-creation to explore and mutually understand the different perspectives are key. Project members have experienced that having such dialogues online instead of in-person has been challenging. One project member explains:

> It [Communication during lockdown] is like we are shouting to each other through a garden hose.

The challenges with digital co-creation meetings and workshops have put an extra burden on many of the project members.

Challenges and how they are handled

In the table below, the LINC project is mapped against the established UIA Challenges. The hard challenges are further elaborated on in the next section.

Challenge	Observation
Leadership for innovation Challenge level	Leadership for innovation is relevant on national, regional, and city levels. On a national level, the leadership for innovation (in terms of enabling tests with AV:s) has been weak. However, after finally announcing the approval, the Danish transport minister has planned to visit the project at the beginning of May, which could be a sign that things might be changing. On a regional level, there used to be a collaboration (called the Loop City agglomeration), but the secretariat closed in 2018 as a consequence of general financial savings. There is still a vision about the new light rail that unites the municipalities in the region and provides a common ground. Once the project has results to present the integration of shared mobility solutions, including self-driving shuttles, in sustainable city planning, a renewed interest is expected. On the city level, there is an interest in new mobility solutions as a part of urban planning. To feed this interest the project needs to deliver evidence and practical tests, which is indeed challenging in the current situation. The project plan for alternative solutions, and do also see hope that the operation finally will start. See elaboration below.
Public Procurement Challenge level	The vehicles to be used in the project have been procured, delivered, and successfully tested together with the supplier. In the long term, when scaling up the solution, public procurement is both a challenge and an opportunity, as new public-private partnerships need to be developed. For example, in non-urban environments, the service might not be profitable by using travel sales only. Then it can be difficult to attract private mobility suppliers. Instead, a business needs to be built on private-public partnerships where mobility is part of urban planning. The project is currently surveying and discussing such partnerships and financing models.
Integrated Cross-departmental working Challenge level	Multiple departments at the City of Albertslund are engaged in the project, including e.g. infrastructure, industry, and business development. Naturally, the departments have different perspectives and roles in the project, but they all share the same vision that the new Light Rail will enable sustainable mobility and increase the number of citizens and workplaces in the municipality. Working towards this common high-level goal has lowered the barriers for cross-departmental working. However, without evidence of how the self-driving shuttles can contribute to the common vision, parts of shared the vision can be lost. The cross-departmental workshop that the project has planned in June (see below), together with the analysis of the results from that workshop, will be important to continue to foster cross-departmental collaboration.

Adopting a participate approach

Challenge level

The project has a clear user participative approach and emphasizes first-hand reactions and inputs from users. Test passengers have been recruited especially among people that are on the Campus despite Covid-19, and people are excited and positive. The test period is carefully planned to enable many different tests together with users.

Monitoring & evaluation

Challenge level

The scope of the tests within the project has changed quite dramatically, from two six-month-long tests at two different sites to one three-month-long test at one site with (for now) only two passengers allowed on the bus at the same time due to Covid-19 restrictions. This does naturally have an impact on what can be evaluated. The evaluation plan has continuously been developed to correspond to what can be tested given the circumstances. For example, the service as such (on-demand with AV:s) cannot be tested, but instead, the project will focus on evaluating the AV technology and the smartphone sensing platform.

Communication with target beneficiaries

Challenge level

The delay in starting the tests with the self-driving shuttles has made communication with target beneficiaries complicated, as the actual test and the test results were planned to constitute the basis of the communication. The tests were expected to visualize the potential with the innovative mobility service to target beneficiaries. The outbreak of Covid-19 has made communication even harder, both because of shifts in priorities at the key stakeholders and because of limited communication channels. However, the project has found ways to keep a relevant dialogue with target beneficiaries, for example through participation in workshops and participation in Copenhagen Light Rail board meetings (see elaboration on this below).

Upscaling

Challenge level

During the project, it has become obvious that neither the legislation in Denmark nor the technology is ready for collective self-driving mobility. In addition, with the long lead times in the legislative process, it is not the most recent technology that is actually tested.

Instead, the project explores which components or learnings can be upscaled in other settings. One example is the Smartphone sensing platform for demand estimation that probably is beneficial for mobility services in general, including for example payment solutions for MaaS (Mobility as a Service) solutions, transport optimization, and deep insights into user preferences.

Focus on the hard challenges

Leadership for innovation and Communication with target beneficiaries

There are two hard challenges in the project, Leadership for innovation and Communication with target beneficiaries. At the core of these two challenges is the fact that the actual tests with the self-driving shuttles are significantly delayed due to external reasons (very long legislative process and COVID-19). The dialogue with decision-makers and target beneficiaries is dependent on if the project can provide tangible evidence or only can talk about the potential benefits.

On the national level, the project has already contributed to improvements by participating in the national dialogue on legislation for self-driving vehicles.

On the regional and city levels, real evidence is central for the project to have a significant impact on urban planning. With the very short test period, that will occur during a time when restrictions due to Covid-19 limit mobility, it is still uncertain whether the project will actually gain the results that they need. The project has met this challenge in several ways:

1. The project plans the tests so that as much data as possible can be collected during the limited time. Then, the researchers can analyze the data after the test has ended.
2. The tests are planned to collect data from what can actually be tested (e.g. the technology rather than the service).
3. Simulations are used instead, to explore the potential of self-driving shuttles in first/last mile services as a complement to the light rail. Simulations can compensate in some perspectives, and even provide more information as they can study areas that are not included in the real-life tests. However, user acceptance and adoption of new services can not be measured in the simulation.
4. Together with the two municipalities in the project an "ideation catalog" presenting ideas that have arisen during workshops in the project. From this, the idea is to illustrate opportunities for the future. This is ongoing work, and a way to build leadership for innovation. The ideation catalog is supplemented by an analysis of the potential for Greater Copenhagen Light Rail linked to a first/last mile self-driving service for Hersted Industrial Site and self-driving shuttles impacts on Sustainable Urban Mobility Planning (SUMP) framework which eventually will lead to new approaches for SUMP.
5. The project is also performing a desktop exploration of sustainable business models for innovative mobility as a part of urban planning.
6. The project has increased its efforts in communication with for example Copenhagen's Light Rail board and other stakeholders.

One main challenge in the project is to get politicians and decision-makers to "buy-in" on the ideas and plans from the project. Autonomous mobility is not a part of the current city master plans in the municipalities, but one success criterion for the LINC project is that it will be in the future. To take one major step towards this, a workshop, organized together with ViaTrafik, is planned for June 2nd, 2021. The workshop gathers key stakeholders including urban planners, traffic planners, smart city consultants, and the public transport agency Movia, to formulate a vision for connected, and shared automated mobility. Anchoring of the vision, and development of a strategy for the implementation of self-driving shuttles to support sustainable cities, is crucial for success. It is important for the LINC project to show the benefits or at least potentials for the decision-makers. The aim of the LINC project is also that one or several of the stakeholders at the workshop will take over the ownership of this vision for future development, or that a new project can be founded on this vision and strategy. The fact that the actual tests with the autonomous vehicles finally have started will hopefully raise energy levels in this question again.

What other cities can learn from LINC

"Self-driving vehicle" is easy to say but still challenging to do.

There are both technical and legal barriers that hinder the implementation of self-driving shuttles, or expressed by the project members:

> We have learnt that the technology is not ready yet to be implemented

> Our understanding of the project has shifted - from a test of a new public transport service to a complex technology development project

The LINC project is not alone in this insight. For example, the heavy truck company Volvo recently announced that they would pause their flagship project due to legislative challenges. This was also discussed in the UIA expert journal no 3 for the project, referring to the Gartner hype cycle, where self-driving vehicles have gone from being at the "Peak of inflated expectations" to be in the "Trough of disillusionment". That said, one other main learning is that it is through pushing the limits things can change.

Waiting and waiting for the legal approval has given the project members the feeling that the air has got out of the balloon. The delays have made people disillusioned about the technology and it is sometimes difficult to attract their attention again. But now when the tests finally can start, there is great external interest!

Design the project to be resilient

A resilient project is a project that does not fail even if it goes wrong (the notion of resilient projects was discussed

A resilient project is a project that does not fail even if it goes wrong (the notion of resilient projects was discussed in project Journal 3), and when designing and running complex innovation projects, resilience is a very important aspect. Both in terms of results from the project, but also for keeping the motivation and engagement among people engaged in the project.

Looking at the LINC, it is obvious that the project has missed one of its original main goals: to run two six-month-long tests with self-driving shuttles and that include tests of an innovative on-demand service. At the same time, the project has achieved many other things: insights about the importance of harmonization of technology, legislation, and policy developments, the development of a technically advanced smartphone sensing platform for detailed mobility demand measurements, and first insights on how future mobility solutions like autonomous collective mobility can support sustainable urban planning. By acting agile and open to new methods (e.g. use of simulation models), the project has managed to adapt to the circumstances and made the most out of the available results.

Urban mobility

See on UIA website